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## The Dock & Harbour Authority



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## Editorial Comments

### The Heysham Jetty.

In this issue appears the first instalment of a paper read before the Maritime and Waterways Engineering Division of the Institution of Civil Engineers on 2nd December, 1947 by Professor A. L. Baker, M.I.C.E., describing the construction of the Heysham Jetty.

This structure provides a berth for oil tankers in close proximity to an oil refinery and constructed as a war time measure, the site was chosen primarily to present as great a difficulty as possible to enemy submarines which might attempt to pursue the vessels to their berth.

The jetty therefore was not in a situation which afforded maximum convenience and safety for vessels berthing for the discharge of their cargoes. It was exposed to the Irish Sea at High Tide and was liable to sudden on shore gales, moreover there was an average tidal rise of 30 feet and a four knot current whose direction varied considerably from being parallel to the jetty head.

It was apparently the intention to hold the vessels between two buoys and to discharge the oil through a submarine pipe line to the shore. However after close inspection of the site conditions by marine experts it was decided that dolphins would be necessary as a safety measure, during on shore gales, against dragging of anchors, breakage of moorings etc.

The principal interest in the paper therefore centres around the special dolphins and fendering arrangements on the jetty head which were adopted in this exposed position and which appear to have been satisfactory for both the large and small vessels catered for.

Due to War conditions, both plant and material difficulties were experienced and the dolphins and the head were built in the open sea from specially fitted out small coasting craft, and by a cantilever frame erected first upon temporary staging piles.

The original design for the dolphins and the head embraced the use of 18-in. by 18-in. hollow reinforced concrete piles. These appear to have given considerable trouble by cracking during driving, and together with other considerations such as the time factor, eventually led to the use of steel box piles which could be handled and driven much more speedily. It would have been interesting if the Author had furnished some details of the reinforced concrete piles which proved unsatisfactory.

One interesting feature of the jetty head is that the deck and horizontal bracing systems were designed as girders spanning the space between the dolphins thus obtaining the assistance of the lateral assistance of all the piles in the tee head in resisting impact stresses from vessels.

The design of the shore section of the approach jetty follows normal principles but that of the intermediate deep water section is somewhat unusual, brought about by considerations of speed of construction requirements—the piles are of steel box section braced up to high tide level, driven by floating craft and extended to deck level by pre-cast concrete, the deck slab being cast in situ with special travelling steel soffit shuttering.

The problem of designing maritime structures to withstand damage to themselves without causing damage to vessels colliding with them is still largely unsolved and will probably remain so until considerably more data is available as to the magnitude of loads produced by moving craft.

With the increasing use of fulcrum or spring fenders, which form a ready means of measuring the intensity of blows, it should be possible for more data of this nature to become available in the future.

We leave our readers to examine the paper in detail and particularly the systems of fendering, the "Bell" type dolphins having excited considerable interest among members at the discussion.

### The Civil Engineer in War.

The Institution of Civil Engineers has recently published for the use of its members a symposium of Papers on war-time engineering problems. The publications have been prepared in co-operation with the Admiralty, Air Ministry, War Office and other Government Departments and comprise comprehensive and authoritative accounts of the more important engineering works of the 1939-45 World War.

There are three volumes, the first dealing with Airfields, Roads, Railways and Bridges, the second with Docks and Harbours, and the third with Properties of Materials, Structures, Hydraulics, Tunnelling and Surveying.

Obviously, the second volume is the one of particular interest to Dock Engineers as it contains papers upon a number of Dock and Harbour works. Among these may be mentioned Nos. 1 and 2 Military Ports, temporary works for the construction of Phoenix Caissons in various dock of the Port of London, the Marchwood Jetty, repairs to the Mediterranean ports, temporary repairs to the locks at Flushing, side launching of heavy craft, development of the Port of Calcutta for war purposes, model experiments on different designs of breakwaters, lay-out assembly and behaviour of the breakwaters at Arromanches, Phoenix breakwaters and the Mullberry Pierheads.

It was natural that during the war a great deal of civil engineering work of considerable importance and ingenuity was carried out

*Editorial Comments—continued*

in Great Britain and elsewhere and that owing to security reasons no publicity was possible at the time. While most of these works arose from military necessity, the majority were capable of wider application, that is to say, to peace-time civil engineering.

It was due to the foresight of the Institution of Civil Engineers that in 1944 arrangements were made to ensure that information of value to the civil engineer would be collated and that papers written by those concerned would be published at a later date in the Institution records. As, in our view, these papers should be disseminated as widely as possible among those engaged on post-war port development schemes, we hope to refer to them again in subsequent issues.

**Trade at South Wales Ports.**

During the last few months there has been a welcome improvement in trade, both inwards and outwards, at the principal ports of South Wales, and by far the most important development for a very long time has been the resumption of coal exports. This revival, although on only a limited scale, is an encouraging feature, as the prosperity of the Welsh ports always has been—and is always likely to be—largely dependent on the export of coal.

Attention was drawn to this important fact at a recent meeting of the South Wales Coal Exporters' Association, when it was pointed out that in the peak period between the wars, in a single year, no less than 40,000,000 tons of coal was shipped through the South Wales ports alone, in contrast with the figure of 4,373,491 tons shipped in 1947. Even this small quantity was largely composed of bunkers and coastwise cargoes, which in effect meant that exports were practically nil.

It is, therefore, heartening to read that the volume of coal exports is increasing, and that during the past few months cargoes have been shipped to at least fourteen of the countries who were customers of the Welsh ports before the recent war. At the same time, it has to be remembered that the Government's export target for coal during the present year is 9,000,000 tons, of which 6,000,000 tons is to go to the European countries being aided by the Marshall Plan, leaving a balance of only 3,000,000 tons for other countries. It will be generally agreed that this small total leaves much to be desired, but even so, it is a step in the right direction, as the extra tonnage being shipped has given employment to many men at the docks, and more coal hoists have had to be brought into use.

General cargo traffics also show signs of an improvement and according to the latest figures available, the total traffic for the first six months of this year for the ports of Cardiff, Swansea, Newport, Barry, Port Talbot and Penarth, amounted to 6,935,432 tons, comprising 2,700,848 tons imports and 4,234,584 tons exports, the corresponding figures for last year being 5,316,723 tons, 2,109,801 tons and 3,206,922 tons respectively. The number of ships using the ports also showed an increase, being 8,295 ships totalling 4,985,067 tons net compared with 7,548 ships totalling 4,443,826 tons for the first six months of 1947.

**Successful Mechanical Handling Exhibition.**

The first Mechanical Handling Exhibition and Convention, held in London last month, and briefly referred to in our July issue, proved very successful. Attendances, consisting almost entirely of visitors directly interested in mechanical handling problems, amounted to over 4,000 a day, and the Convention sessions also were well attended.

A particularly satisfactory feature was the large attendance from abroad, and visitors from at least 23 foreign countries were much impressed by the rapid strides made by British manufacturers in many new types of handling equipment, such as fork-lift trucks, which until recently all came from the United States of America, and by a number of improvements in the cranes, hoists and conveyors, for which British manufacturers have long had a world-wide reputation.

There is no question that, as a result of the Exhibition, the fork-lift truck and pallet system of handling goods will be more widely used in this country, and there also will be an increased demand for other handling equipment, such as mobile conveyors and work

trucks of all kinds, which are readily adaptable to existing factory and transport organisations. A simple conveyor for truck loading and unloading at every railway station in the country is believed to be one of the Railway Executive's aims, and we suggest this system could be adopted far more widely at many ports.

The reports of the exhibitors are encouraging as far as the export trade of the country is concerned, as they show that Great Britain can still further increase her sales abroad. In this connection, well-known crane and hoist manufacturers said the Exhibition was a most satisfactory one, because it was highly specialised and attracted only actual or potential users of the equipment. One enquiry for conveyors for unloading ships ran into six figures, and other conveyors were required for many different purposes. Thousands of pounds' worth of pallets were sold for Colonial development schemes, and an initial order for £50,000 for contractors' plant came from the Argentine. Gears, chains and accessories of all kinds also attracted hundreds of enquiries.

**Centenary of the Port of Bristol.**

On the 30th June last was commemorated a notable occasion in the annals of the City of Bristol, when celebrations were held in connection with the centenary of the Bristol Dock Act of 1848, by which the ownership of the City Docks was finally vested in the Corporation.

The celebrations commenced with the unveiling of a commemorative plaque at the City Centre by Alderman A. W. S. Burgess, Chairman of the Docks Committee of the Bristol Corporation. Guests and members of the Corporation and officials from the Port Authority then boarded the steamer, "Bristol Queen," which steamed through the City Docks and down the River Avon to the Royal Edward Dock at Avonmouth, where luncheon was served and a number of speeches were made, including one by Mr. Alfred Barnes, the Minister of Transport, who paid tribute to the magnificent service the port had rendered the country during the recent war, when it handled a total of 42,000,000 tons of goods.

Speaking at the unveiling of the plaque, Alderman Burgess said that Bristol figured prominently in the maritime affairs of this country many centuries before the municipality decided to take a hand in the management of the docks. There was a time, before the industrial revolution took trade northwards, when Bristol ranked, as a port, second only to London. Thereafter the fortunes of the port waned, and for a long period of years little or no effort was made to keep abreast the rapidly changing times.

When the Corporation took over the reins one hundred years ago, the whole trade of the port was accommodated at the City Docks. Other docks, under private ownership, were eventually constructed at the river mouth at both Avonmouth and Portishead and were opened to traffic in 1877 and 1879 respectively. There then ensued a ruinous competition between the three separate interests—the City Docks managed by the Corporation and the two private docks at the river mouth—each of them making frantic bids for a share of trade. Once more the Municipality stepped in and, in 1884, by the purchase of these rival undertakings, all the docks within the port became the property of the Corporation.

Those not familiar with the financial side of the docks undertaking may be interested to learn that the total capital expenditure to date is in the region of £11½ millions sterling, and during the hundred years of civic administration, out of the capital sum expended of £11½ millions, £6 millions have been repaid, of which no less than £4 millions has been provided from the revenues of the docks undertaking. The modern character of the dock accommodation and equipment is emphasised by the fact that 81% of the outlay on capital works has been expended during the past 50 years.

We congratulate the Corporation of Bristol and the officials of the port upon their past achievements, and especially upon their successful efforts to foster the trade of the port since the cessation of hostilities. Last year's trading figures speak for themselves, as they constituted a peace-time record, exceeding the previous peak year of 1939 by several hundred thousand tons. There are, therefore, substantial grounds for optimism and for confidence in the future welfare of the port.



### The Heysham Jetty—continued

weight of the bell when ballasted with concrete blocks is 170 tons. The work done, therefore, by a ship in pressing the bell to its extreme position is 1,900 inch-tons, which is an amount sufficient to absorb the kinetic energy of a 15,000-ton vessel swinging against the fenders at bow or stern at a speed of 1.25-ft. per second.

These shock-absorbing values are very much in excess of those which can be obtained by a system of springs or ordinary timber fenders. The bell is also free to rotate, so that from whichever direction a blow is received, the fendering always recedes from the ship in a highly resilient manner. The rotation of the bell also facilitates the replacing of rubbing strips on the fenders, as the work can proceed on the in-shore side of the berth and new fendering be placed in position when required by merely rotating the bell.

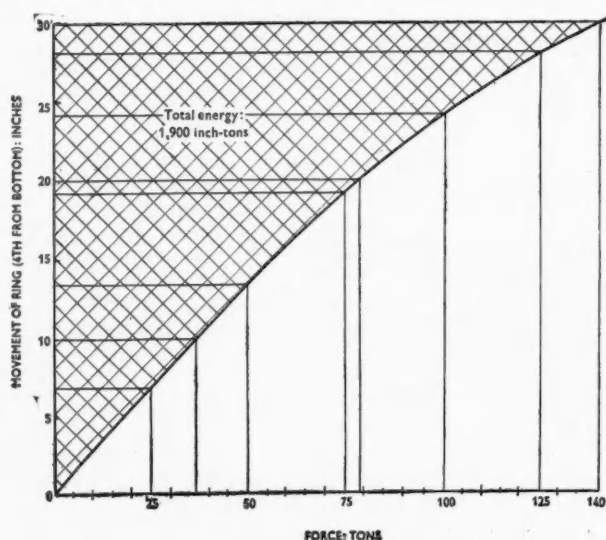


Fig. 1 (c).—Energy Absorption of Dolphin Bell.

The central pintle which prevents the bell from moving off its bearings also acts as a bollard. Lorry tyres are suspended on the inside of the bell so that if ever the bell is pushed to its extreme position, a considerable reserve of shock-absorption is provided before the bell makes rigid contact with the pile-cap. Furthermore, the ribs of the bell would probably buckle before a horizontal force large enough to overturn the whole structure could develop. This depends on the increase or otherwise of the resistance of the piles to extraction as time passes.

It was originally intended to construct the bells and the complete dolphin in reinforced concrete but, as will be explained later, early completion of the work became an increasingly important factor and it was found necessary to use steel construction in order to gain time. It was originally intended to construct the two dolphins 300-ft. apart (centre to centre) in order to accommodate 15,000 to 20,000-ton tankers of the Regent class and to use only a small island platform between the dolphins for handling hoses, etc. The results of driving test-piles and carrying out extraction tests, however, indicated that less pile anchorage could be relied upon than had been anticipated. It was therefore decided to connect the two dolphins by a horizontal deck beam so that the limited number of raking piles which could be driven within the circumference of the cylindrical dolphin caps could all act in one direction and combine to great advantage in resisting horizontal blows normal to the face of the jetty. The connecting deck beam combined the resistance of all the piles throughout the structure in bending to resist longitudinal forces, the total number being sufficient to resist the maximum forces which could be expected. The horizontal deck beam also served the purpose of transmitting horizontal blows which might be received from small vessels berthing between the dolphins back to the latter and to the central T-head, thus avoiding the expense and difficulty of driving raking piles between the dolphins and the T-head.

A contract was placed for the construction of the dolphins and the connecting decking, etc., and the work of casting piles and completing detailed working drawings commenced. The enlargement of the shore project from an oil storage depot into a refinery then made it necessary to increase the number of pipe-lines from the berth to the shore and the frequency with which the berth was to be used, thus justifying the construction of an approach jetty which would obviate the need for submarine lines and also provide access by car or small lorry to the berth.

It was too late to make use of the approach jetty either in providing a support to the T-head with respect to horizontal blows from tankers, or in assisting the construction of the dolphins and T-head by providing road access, except towards the very end of of the whole construction programme.

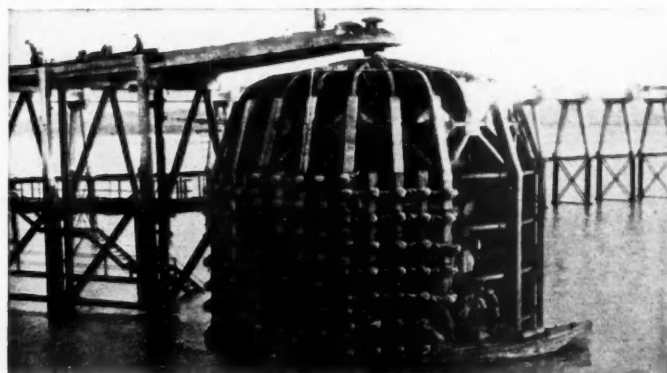


Fig. 2.—South Dolphin.

Staging, supported by temporary timber piles driven from craft, was constructed to support a pile frame on a travelling under-carriage for driving 90-ft. long hollow reinforced concrete piles for the T-head decking and dolphins.

The results of driving the first few piles were not satisfactory. The concrete of the piles was excellent, but excessive cracking occurred, due probably, to high shrinkage stresses. Furthermore, the time required for handling and driving and possibly extending the piles was so excessive that it was clear that only by changing over to box-section steel piles, which could be driven at several points simultaneously from craft, could the work be sufficiently accelerated in order to ensure completion within a period of about 12 months, which was vital to the purpose of the whole scheme. Also it was decided at the same time, for the same reason, to use steel for the construction of the bells of the dolphins, the bracing and supports to the T-head decking, and the low-water bracing to



Fig. 3.—Deep-water Section Approach Jetty.

steel piles which were to be used throughout the deep-water section of the approach jetty (Fig. 3). It was not possible until that stage was reached to proceed with the final working drawings of the whole scheme, and the basis of design for each section of the structure was then finally decided upon in accordance with the following summary.

*The Heysham Jetty—continued***Summary of Tests and Design Data**

**Borings.**—The sea-bed was found to be boulder clay covered by silt. (During construction it was found that over some sections the silt was 10-ft. thick and offered no resistance to piles. The latter when driven caused eddying in the tidal flow and hence scouring of the silt. That was prevented by depositing a blanket of stone ballast).

**Test-piles.**—Test-piles indicated that a penetration of 15-25-ft. of the concrete piles in the boulder clay would provide an ultimate resistance of 150-200-tons calculated by the Hiley pile-driving formula, and a resistance to extraction of 15-20-tons. It was assumed that the latter would increase to 30 tons, a few months after driving.

**Design loads.**

**Horizontal forces on dolphins:—**

- (1) Impact from 15,000-ton vessel at 1.25-ft. per second side blow at all states of tide.
- (2) Static pull on bollard (a) normal to jetty face: 270 tons; (b) parallel to jetty face: 200 tons.



Fig. 4.—General view of Crane Deck.

**Horizontal forces on approach jetty:—**

- (1) 3-cwt. per sq. ft. on parapet wall; or
- (2) a single concentrated load at any point of 30 tons.

The deck level was set out 8-ft. above highest known tide-level in order to minimise pressure from wave action).

**Vertical loads:—**

- (1) 200 lb. per sq. ft. load on decking; or
- (2) lorry with 1-ton axle loads.
- (3) Reactions from cranes.

**Crane Deck and Dolphins**

The general form and arrangement of the various sections of the structure, as shown in Figs. 4 and 5, was evolved as follows:—

In the case of the dolphins, the arrangement of the piles was worked out to give minimum thrust or tension forces for the worst combinations of horizontal and vertical forces at various states of the tide, the latter forces of course being kept within safe limits as regards the strength of the piles and the resistance of the sea bed either up or down.

The piles were B.S.P. L.P.4 steel box piles driven to a minimum penetration of 18-ft. Generally, penetration required to be only 20-ft. to provide sufficient resistance but in some cases penetration

reached as much as 70-90-ft. Extensions were made by means of welding. On completion of driving, "colcrete" was pumped into the piles in order to reduce the risk of internal corrosion and to provide additional strength in compression. Splice bars were used to tie the ends of the piles into the pile-cap. The pile-cap was constructed of 4 : 2 : 1 mass concrete in the main, but vertical and circumferential reinforcement was used to prevent shrinkage cracks on the outside and generally to hold the pile-cap together as a solid homogeneous mass. The pile-cap bearing was constructed with a series of concentric polygonal ribs having three webs (Fig. 6). The polygonal ribs were strong enough to spread a point load received from the bell structure over a sufficient area of concrete to prevent crushing; the ribs of the bell, being radial, always crossed the ribs of the lower bearing, and so it was assured that the concrete bearing-stress could not be excessive; nor could the steel stress if it was uniformly distributed throughout the area of contact between the ribs of the bell and the ribs of the lower bearing. In addition, the space between the ribs was filled with a special high-grade granolithic concrete which was ground down flush with the ribs after hardening. The surface of the lower

bearing was covered with a  $\frac{1}{2}$ -in. layer of thick bitumen grease which was continually lubricated by a slow drip of oil from a wick projecting from a special lubricator clamped around the central pintle. It was found later that, when the bell rolled, the layer of bitumen grease was sufficiently stiff to withstand the bearing pressure, thus providing an easy motion for the rolling and rotational movement of the bell.

The central pintle was constructed of welded rolled-steel plate with extension splices for anchoring into the concrete. The bell itself was constructed as a structural steel framework, shop riveted in sections, and bolted together on site. The main ribs radiate from a central collar, and point loads, either from the ships or from the point of bearing, are spread to adjacent ribs by ring girders. The main shear stresses of the structure as a whole are resisted by light diagonal bracing. It was impossible to calculate exactly the stresses in the bell as a statically indeterminate framework, but calculations of the cross-sections of the ribs were based on the assumption that each rib developed its maximum bending moment when a point load from a ship or from a point of bearing acted on that particular section. It was then assumed that the circumferential ribs were stiff enough not to yield as supports and bending moments due to the

## The Heysham Jetty—continued

point load spread over at least three radial ribs. The maximum horizontal forces could be determined directly from the weight of the bell. Ballast to provide additional weight took the form of concrete blocks which were seated on one of the horizontal ring girders.

In order to minimize corrosion, all steelwork was painted with horizontal retort tar. Fendering is greenheart with elm rubbing strips. In order to prevent excessive swinging of the bell building up at high tide during rough weather when the waves tend to lift the side of the bell through upward pressure on the horizontal ring girders, special wedge-shaped steel blocks are inserted in the bearing of the bells and removed before the berthing of a ship. There is no risk of rolling building up due to wave action when a ship is berthed, since the ship itself acts as a breakwater.



Fig. 5.—General View of Approach Jetty.

The connecting deck between the bells serves the following purposes:—

- (1) It acts as a horizontal beam spanning horizontal loads, received by fendering between the dolphins, back to the raking piles at the centre of the deck and to the pintle of the dolphins, and hence through the pile cap to a system of vertical and raking piles.
- (2) It acts as a horizontal tie combining the resistance in bending of all the piles in the structure in resisting longitudinal forces. During rough weather it was found that longitudinal sway of several inches developed, but that was eliminated by the use of anti-sway bracing which took the form of a diagonal steel tie at each end of the decking connecting the foot of a pile adjacent to the dolphin to the top of one of the dolphin piles.
- (3) It supports general deck loads and the reactions from the cranes.

The deck slab is supported on pairs of vertical piles with diagonal bracing and extensions above low-water level.

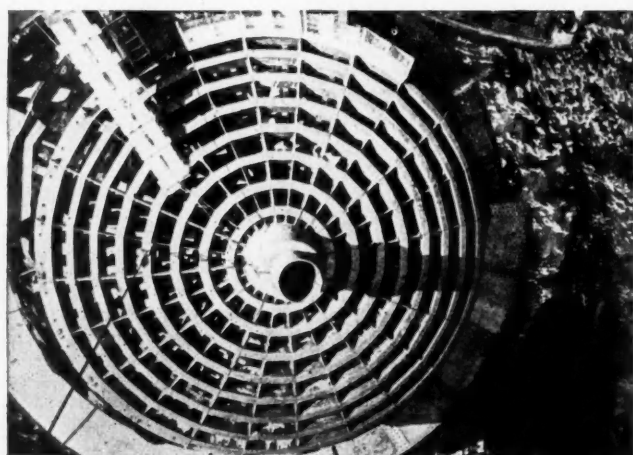


Fig. 6.—Bearing Cap before Concreting.

Mid-way between low-water and high-water level an access gangway is provided, and horizontal bracing forms a beam, spanning horizontally and assisting the deck beam in spreading horizontal blows received at low water or half-tide level.

### Approach Jetty

The design and construction of the approach jetty can be divided into three sections.

#### (1) Shore section.

Reinforced concrete piles were driven from a frame carried on a specially travelling staging which kept the boiler and winches above high-water level. The deck was supported directly on the piles or extensions. At certain points it was found advisable to provide horizontal bracing at beach-level, where piles developed high penetration and were surrounded by silt overlying boulder clay which became almost fluid at high tide.

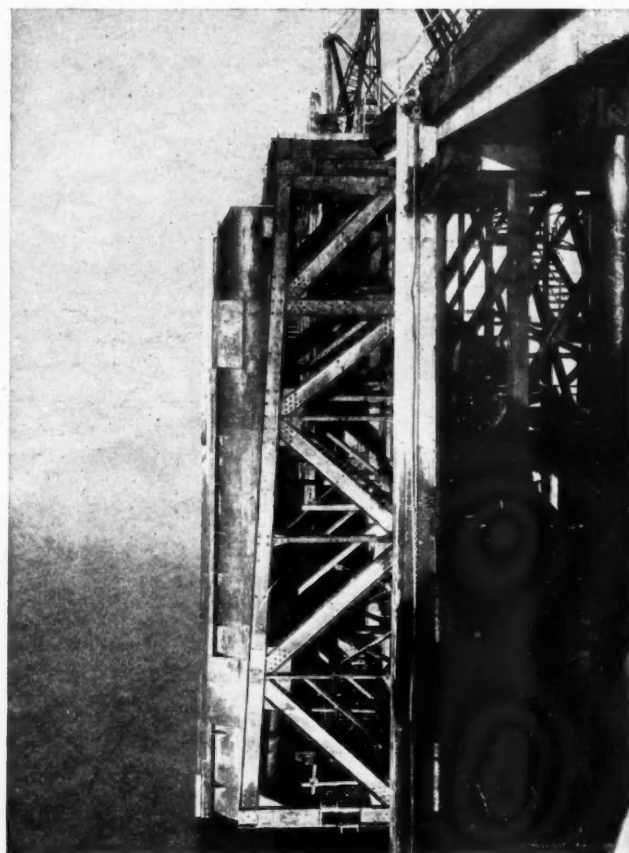


Fig. 7.—Fenders.

#### (2) Intermediate deep-water section.

It was intended to construct the whole of the deep-water section with reinforced concrete hollow piles, handled and driven by a cantilevered pile frame, supported by the concrete piles and braced with deep, stiff, pre-cast crossheads. Pre-cast extensions were to be handled into position and fixed thereto from the back of the travelling cantilevered frame, thus extending the pile cross-head up to deck level as the pile frame travelled forward.

That procedure was found to be too slow, and the work was accelerated by using specially equipped craft to drive steel piles throughout the greater part of the deep-water section. Those piles were braced with steel and extended from about half-tide level to deck-level with pre-cast concrete. The procedure was greatly facilitated by the use of special steel templates and the work of concreting the top cross-heads and concrete roadway and parapets was greatly helped by the use of special travelling shuttering. The concrete roadway and

## The Heysham Jetty—continued

parapet took the form of a channel beam which spread horizontally by concentrated lateral roads due to wave action. Pipe-lines were conveniently supported by extensions of the cross-heads and in that position obviated the need for railings

### Construction Methods and Cost

The Contractors adopted a policy of carrying out as many operations as possible from floating craft, partly in order to accelerate the work and partly to minimize the risk of loss of or damage to plant during rough weather. It was thought that there was less risk of serious accidents if that were done, since in very rough weather ships could be kept in Heysham Harbour, or in the event of a gale springing up ships could quickly return to harbour. The procedure proved expensive but assured the progress of the work and no major accident occurred. It can probably be claimed that the policy was a sound one because some of the storms which caused damage to the partly-constructed approach might quite possibly have overturned heavy pile-frames carried on temporary staging or cranes in a similar position, thus delaying the work for an indefinite period. A cantilevered pile-frame was used to drive most of the piles in one of the dolphins and the elaborate staging provided proved adequate but gave an indication of the amount of temporary construction work which would have been necessary had the whole of the work been carried out in the same way from temporary staging.

The construction of the crane decking was greatly facilitated by lowering pre-fabricated steel bracing into position from a ship's derrick. The same applied to the construction of the steel bracing and extensions of the approach jetty in concrete. As an indication of the speed obtained by driving steel piles from craft, as compared with concrete piles from cantilevered frames, the records show that two or three steel piles were driven per day in the deep-water section of the approach jetty and only two concrete piles per week by means of the cantilevered frame, although it should be pointed out that concrete extensions were constructed at the same time at the back of the cantilevered frame.

The construction was completed over a period of about 18 months at a total cost, including contractors' profit, of about £275,000. In normal times there is no doubt that the total cost would have been considerably less, since a longer time would have been possible to arrange for the work to be carried out mostly during the summer months. During the winter considerable costs were incurred through standing time for the rather exceptionally large amount of plant and craft and men concentrated on the site, in order to ensure the completion by the required date.

### Operation of the Berth

The novel feature of the dolphins at first excited considerable comment and, in some cases, opposition from marine experts; at one stage it was almost decided to abandon the work. It was therefore, a particularly critical situation when, two days before the first tanker was due to arrive, a storm set the "bells" swinging and some of the bolts joining the radial ribs to the central collar began to stretch, with a risk of the centre of the bell breaking up. A period of exceptional calm followed the storm and, by working day and night and concentrating as many welding sets as possible on the crane decking, all joints between the ribs of the bell and the central collar were loosened, the connecting plates removed, and all finally welded together.

Fortunately the calm continued and the "bell" remained steady during the re-construction and the last weld was completed about 15 minutes before the first ship came in to berth. There was considerable reluctance at first to come alongside, but eventually the tanker officials were persuaded to take the "risk" and on colliding with the bells found that all shock was taken up by the rolling action so that the force of impact was negligible.

After the first trial, tankers continued to use the berth and the Berthing Master very quickly accepted the dolphins as satisfactory. In fact it became customary to bring vessels alongside by bumping into the dolphins instead of winching into position with mooring ropes.

Throughout the war and up to June 1946, tankers have continued to use the berth and on many occasions, in bad weather or through the breaking of a mooring rope, etc., the special function of the dolphins for reducing what would otherwise have been a serious collision has been clearly demonstrated and provision of the rotary action of the bells justified. On some occasions vessels have remained in the berth during a storm which has caused them to rise and fall as much as 12-ft. and range 15-20 feet horizontally to and from the dolphins.

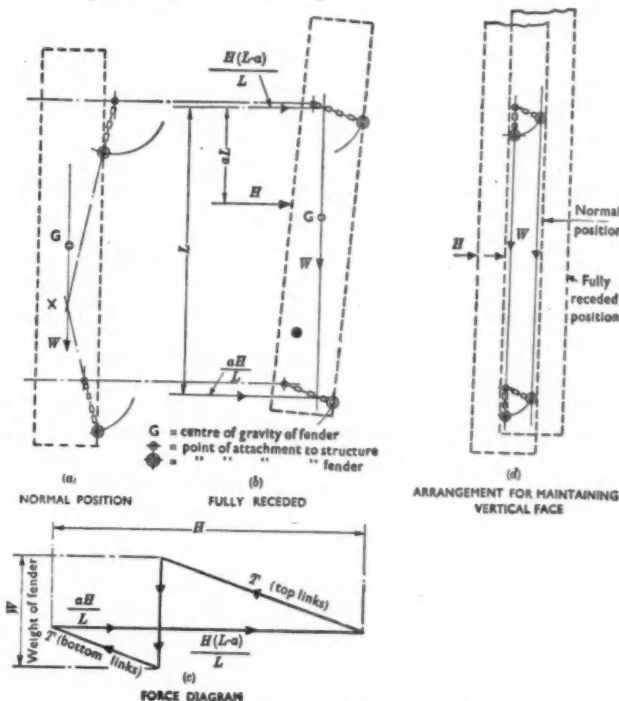


Fig. 8.—Forces on a Suspended Fender.

A special indicator, which is probably the only one of its kind, has been installed on one of the dolphins in order to measure the force, in tons, of blows received during collisions. It is quite a simple device, since the degree to which the dolphin rolls over under the impact is proportional to the force of impact. It is quite simple, therefore, to provide a scale which merely converts angle of tilt into tons pressure. Observations of this indicator show that the kinetic energy of a vessel, as would be expected, can be calculated from the usual formulae, and that a glancing blow received from the bow or stern swinging towards the berth has about 40 per cent. of the kinetic energy of a head-on-blow.

### Additional Suspended Fenders

Towards the end of the war it was found necessary to bring shorter and more highly flared vessels into the berth, so that, at the dolphins, the ships no longer presented a vertical side for pressing against the fendering. The jetty structure between the dolphins was too weak and did not project out far enough to receive the pressure from such vessels. It was therefore decided to install, between the dolphins, on cantilevered frames, a special type of suspended fender having similar shock-absorbing properties to the bells. Fig. 7 shows the suspended fender in position and Fig. 8 illustrates the principle on which it operates.

The fenders were constructed of 3-ft. 6-in. diameter steel tubes ballasted with pre-cast concrete blocks making a total weight of 30 tons. They are suspended by four links, two at the top and two at the bottom, in such a way that, normally the face of the fender is vertical, but when pressed back by a ship a link motion is set up, so that as the fender recedes about 42-in. it rises about 30-in., thus absorbing 900-in. tons of kinetic energy. These fenders provide a much greater shock absorption value than any form of

### The Heysham Jetty—continued

spring or hydraulic buffer device, and also have no mechanical parts which might jam at the critical moment of a collision. They have freedom to rotate slightly and move in a longitudinal direction, so that friction and jarring in the case of glancing blows or longitudinal rubbing is minimized. They also add weight to the side of the jetty structure adjacent to the ship which provides additional safeguard against the piles uprooting.

#### Adaptions

It is perhaps of interest to relate that a further development of these fenders was applied to an existing mass concrete mole at Inchkeith Island in the Firth of Forth, where damage to ammunition vessels rounding the end of the mole during rough weather was prevented. A further adaption was used on the pierheads at "Mulberry", enabling the L.S.T.'s to berth at a speed of 4 knots without damage and the time of berthing to be reduced from about 45 minutes to 15 minutes.

#### Conclusions

It is hoped that out of the special circumstances of the war, in which Dock Engineers and Ship Owners combined to minimize damage to shipping, will arise a new attitude towards the design and construction of wharfs and jetties. It is now possible for light open piled concrete structures to be used with great saving in cost on sea-beds of low supporting power and to provide berths for large ships on exposed sites by providing sufficient resilience to allow collisions to take place without damage.

The degree to which this can be done can perhaps be best realized by stating that an ordinary type of jetty under impact does not recede more than 1-2 inches. If such a jetty is therefore

equipped with heavy fendering capable of receding 40-50 inches during the course of stopping the motion of a ship, the force of impact is reduced to between one-twentieth and one-fiftieth.

#### Acknowledgments

As in most large works, the satisfactory construction of Heysham jetty was the result of the collaboration of a number of engineers, of whom should be mentioned specially Mr. W. B. Heaton, of Trinidad Leaseholds, Limited, to whom the Author is indebted for much encouragement in proceeding with the design and construction of an entirely new type of dolphin of fairly large dimensions.

The Norwest Construction Co., Ltd., who were the principal contractors, should be complimented on their persistency in carrying through a most difficult work of construction. Mr. O. N. Arup (assisted by Mr. R. S. Jenkins, A.M.I.C.E., who should be mentioned in connection with special calculations, and Mr. Martin, who designed travelling shuttering), acted as Consultant to the Norwest Construction Co., Ltd., and provided detailed working drawings and detailed calculations for the reinforced concrete work and the main sections of the structural steel work. The construction of the latter and provision of detailed working drawings were carried out by Messrs. McIntyre & Co., Ltd. (Liverpool), under the direction of Messrs. Hughes & Cunliffe. Structural steel was supplied by the Consett Iron & Steel Company. The contract for supplying and constructing the suspended fenders was carried out by Messrs. John Mowlem & Co., Ltd., of whose staff Mr. J. Horne (assisted by Mr. V. G. Hatherley, of Trinidad Leaseholds, Ltd.) contributed considerably to the detailed design.

## Indian Ports and their Future

### A Survey of the probable effect on the Trade passing through Indian Ports, following the partition of India into the Dominions of India and Pakistan

By G. E. BENNETT, M.Sc., M.Inst.C.E., M.I.Mech.E.  
(Late Chief Engineer and Chairman of the Port of Bombay).

The partition of India into the two Dominions of India and Pakistan has created many curious anomalies which greatly affect the trade passing through the ports and railways serving them.

In the map below, the Dominion of India has been shown cross hatched and the Dominion of Pakistan vertical hatched. From this can be clearly seen the great geographical difficulties that will now be encountered. The main area of Pakistan on the West, consisting of Baluchistan, Sind and The North West Punjab has been separated from the area of Pakistan on the East, consisting of Eastern Bengal, by the great bulk of India, a width of some 1,200 miles; also the great bulk of India is separated from its Eastern portion, comprising the hill areas of Assam, by the Area of East Pakistan.

The map also shows the problem of the two powerful States of Hyderabad and Kashmir, not yet included in the area of either Dominion. Hyderabad, in the centre of India, a rich and powerful state under the autocratic rule of the Nizam, is surrounded by the Dominion of India. It has no port, no gateway to the world beyond India, and will be dependent on the goodwill of India for interchange of trade. Kashmir, in the north, is in a similar position. It is at present a subject of contention between the two Dominions, and the question of its future is now before the United Nations Organisation.

There is the further problem of the foreign territory in India. The Portuguese territory round Goa, on the West Coast between Bombay and Cochin; the French territory round Pondicherry on

the East Coast below Madras; and the French territory round Chandranagore, on the Hooghly River above Calcutta. Of these only Goa has a port of any importance, the Port of Marmugoa. The strong nationalist feeling in India will most certainly cause all possible steps to be taken to squeeze out these foreign areas, and in fact proposals for the establishment of a port closely adjacent to Marmugoa are already under consideration. This would divert from Goa all trade passing from India and isolate it.

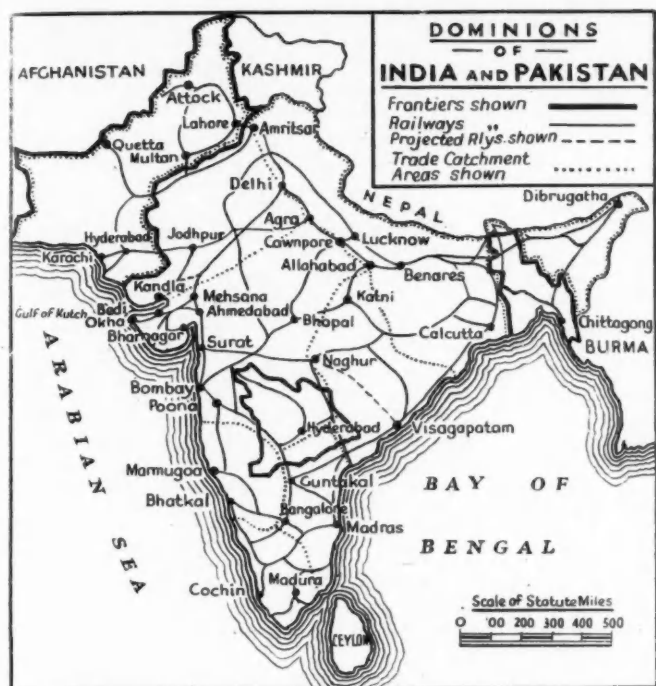
#### Future Trade of the Dominions

In addition to the geographical difficulties, there are vital differences in the commodity and trade assets of the two Dominions which require goodwill and a spirit of give and take, if trade is to flow smoothly between them.

In general, Pakistan has the food and raw materials for manufacture, and India has the coal and the industries. The great grain-growing areas of the Punjab are in Pakistan and this grain is required to meet the deficit in India. The jute-growing areas in Bengal are in Pakistan, whereas the jute mills, also in Bengal, are in India. A similar situation arises in regard to cotton, India depends on Pakistan's raw cotton to feed its mills and Pakistan looks to India for cloth. India takes a million bales of raw cotton every year, and Pakistan needs about 8 million yards of Indian cloth. Pakistan has no coal. The great coal fields in Behar and the Central Provinces are in India, and Pakistan requires coal for its railways and industries. At a rough estimate, it will require about 2 million tons a year for the railways alone. The great steel works are in India, at Tatanagar in Behar about 150 miles from Calcutta, and in Mysore in South India. The great majority of manufactures also are in India, the main centres being Bombay, Calcutta, Cawnpore, Madras, and Ahmedabad. The only manufacturing centre of comparative size in Pakistan is Lahore. Petroleum is found in both Dominions, in India at Dibrugarh in North Assam, and in Pakistan at Attock in North Punjab.

The interchange of Commodities between the two Dominions will therefore be largely, food grains, raw cotton and raw jute from Pakistan in exchange for coal, iron, cotton textiles, sugar, jute manufactures, and manufactures generally from India.

## Indian Ports and their Future—continued



The following figures give an appreciation of the trade position of the two countries and the interchange of trade:—

	1945—46	
	In Millions £ India	Pakistan
Balance of trade in merchandise ...	+21.35	- 3.90
Internal trade in raw cotton, raw jute, and food grains ...	-71.25	+71.25
Internal trade in coal, iron, cotton textiles, sugar, jute manufactures, also other manufactures ...	+67.50	-67.50
Nett balance of trade ...	+17.60	- .15

### Railways

Only two railways are involved in the process of partition, the North Western Railway and the Assam Bengal Railway. The North Western Railway can be divided into two classes, the strategic and the commercial lines. The strategic lines account for a little more than 1,500 miles and lie exclusively within the jurisdiction of Pakistan. They do not call for any physical partition. They were constructed and operated as a deficit concern, at the cost of the exchequer, primarily for the security of the frontier to the North West, and it is only just that in view of this purpose they should be taken over completely by Pakistan. The commercial lines of the North Western Railway are divided between Pakistan and India, approximately in the ratio of 65% and 35%.

The Bengal Assam Railway consists of both broad gauge and metre gauge lines, and a rough computation, each of the two classes of routes will be divided equally between the two dominions.

The total route mileage of railways open in India in 1945-46 was about 40,500, out of which the mileage open on State Railways was about 33,000. The total length of line allotted to Pakistan will be in the neighbourhood of 7,000 miles, or a little over 21%.

### Customs Duties

At the time of writing, Customs duties are not levied on goods passing the frontier between the two Dominions with the exception that Pakistan recently declared an export duty on jute. India retorted with the threat of an Export Duty on coal. It appears probable that this attitude will result in a series of repercussions which will develop into a tariff table covering all classes of goods

crossing the frontier between the two Dominions. A tariff wall of this nature will restrict the flow of trade between the two Dominions and largely confine the trade catchment areas of the ports to the Dominion in which they are situated.

### Major Ports

The partition of the ports is in accordance with the Dominion in which they are situated, the Ports of Bombay, Cochin, Madras, Vizagapatam, and Calcutta being allotted to the Dominion of India and the Ports of Karachi and Chittagong to the Dominion of Pakistan.

An appreciation of the relative importance of the ports before partition can be obtained from the table below:—

Principal Commodities and Tonnages of Goods Handled 1939—40				
Name	Imports	Exports	Total	
Karachi ...	Coal, Cotton Piece Goods, Iron & Steel, Machinery, Petroleum in bulk	Raw Cotton, Food Grains, Oil Seeds, Oil Cake, Hides	856,324	2,134,335
Bombay ...	Coal, Cotton Piece Goods, Iron & Steel, Machinery, Raw Cotton, Timber, Petroleum in bulk	Raw Cotton, Oil Seeds, Oil Cakes, Manganese, Wool	3,350,000	5,825,000
Cochin ...	Coal, Paddy, Rice, Petroleum in bulk	Pepper, Mineral Sand, Coir, Tea, Nuts	272,341	951,363
Madras ...	Coal, Food Grains, Cotton Piece Goods, Timber, Metals	Raw Cotton, Oil Cake, Seeds and Nuts, Hides and Skins, Vegetables, Tobacco	895,651	1,297,606
Vizagapatam	Chemicals, Machinery, Teak, Provisions	Linseed, Manganese, Oil Cake, Hemp, Ground Nuts	32,412	524,639
Calcutta ...	Food Grains, Timber, Metals, Cotton Piece Goods, Petroleum in bulk, Salt	Coal, Oil Seeds, Tea, Hides and Skins, Oil Cake, Manganese Ore	2,948,671	9,965,911
Chittagong ...	Food Grains, Metals, Petroleum in bulk, Salt	Tea	470,515	598,330

### The Major Ports of India

Of the total of 21½ million tons handled by the principal ports of India, including Kathiawar ports not given above, but excluding Marmugoa, the Ports of Karachi, Bombay, Madras and Cal-



### Indian Ports and their Future—continued

cutta handled 18½ million tons, i.e., about 87% of the total. This very heavy concentration of traffic at these ports, is the cause of serious congestion both in the ports and on the main line railways serving them.

#### The Armstrong Committee of 1946

This congestion was so severe a handicap during the World War that the Government of India in 1946, before partition, set up a technical committee to investigate the possibilities of additional ports to ease the position. The terms of reference were as follows:

- (1) Whether a sheltered deep-water port on the East Coast of India for the accommodation of ships of large size at all seasons of the year is required, whether construction is feasible and if so, where; also what measures are necessary for establishing it.
- (2) Whether there is any justification for the conversion of any Minor Ports on the Coast of India to Major Ports, if so, whether such conversion is practicable, also whether there are any other projects for construction of Major Ports which ought to be considered.
- (3) What steps are necessary to develop Minor Ports in order to meet possible demands of coasting shipping traffic.

The Committee, under the Chairmanship of Sir Gilbert Armstrong, submitted its recommendations to the Government of India in May, 1946, more than a year before the partition of India.\*

Summarised, the Committee recommended that an expansion of the facilities of the Port of Vizagapatam would best meet the first term of reference. With regard to the second term of reference, they favoured the development of the Port of Sika as a Major Port. Sika is a small fishing port on the south side of the Gulf of Kutch, and has an excellent natural harbour, well sheltered, with ample depth of water for the construction of quays for deep draft shipping. With regard to the third term of reference, the Committee considered that nothing would be gained by developing the ports on the West Coast except for small improvements desirable in the interests of the passenger traffic, as the Minor Ports South of Bombay are far from the railway and have natural disadvantages which make development difficult. On the East Coast the littoral sand drift is the bane, and hinders the natural growth of the Minor Ports.

#### The New Committee, Following Partition

The partition of India into two Dominions has brought a fresh aspect into the problem, and the Dominion of India have constituted an expert committee known as the "West Coast Major Port Development Committee" to review the position from the Dominion angle, their terms of reference being as follows:—

- (1) Whether a deep sea port on the stretch of coast covering Kathiawar and Kutch for the accommodation of ships of large size and tonnage at all seasons of the year is required. If so, where it should be sited, having regard to construction and maintenance costs, allied transport developments, possibilities of developing existing ports, and the needs of the extra area to be served.
- (2) Whether a deep sea port between Marmugoa and Cochin for the accommodation of ships of large size and tonnage at all seasons of the year is required. If so, where it should be sited and what measures are necessary for establishing it.
- (3) What improvements are necessary in communications to the existing ports, also what other measures should be taken for the development or provision of additional facilities in these ports.

This Committee, which is under the Chairmanship of Mr. Kasturbhai Lalbhai, has not yet published its recommendations.

Since the date of the submission of the recommendations put

forward by the technical committee under the Chairmanship of Sir Gilbert Armstrong, the possibilities of expansion of the Port of Kandla, in Kutch State on the north side of the Gulf of Kutch, has been closely investigated by the leading firm of Consulting Engineers. The objective is to divert the trade of the States of Rajputana, now flowing through the metre gauge system to Karachi, through Hyderabad (Sind). It is especially well situated geographically to do this, as a link of 212 miles of metre gauge railway of simple construction would connect it to the Jodpur Railway at Ranawar, and so tap the whole network of metre gauge systems of this area right up to Delhi. A broad gauge link to the Bombay, Baroda, and Central India Railway is also proposed. This would have the effect of diverting to Kandla the broad gauge traffic now carried by the North Western Railway to Karachi from the area outside the Dominion of Pakistan.

The investigation of the Consulting Engineers proved that Kandla has a well-sheltered deep-water harbour possessing great possibilities of development, and the choice will most probably be between the expansion of the Port of Sika, as recommended by the Armstrong Committee, and the more recently investigated Port of Kandla. Whichever is finally selected the result will be to confine the trade flowing through Karachi to the borders of Pakistan.

With regard to the second point of reference, there has been under examination for many years, a proposal for developing a port at Bhatkal, about 100 miles south of Marmugoa, and experts consider that Bhatkal is capable of development into a Major Port at a reasonable cost. The railway connection to the metre gauge section of the Madras and Southern Mahratta Railway is only about 49 miles in length, but includes a severe ghat section, the expense of construction of which has, in the past, been the main factor preventing the development of the port. The Dominion objective of diverting to a Dominion port, trade now flowing from the Dominion through the Portuguese Port of Marmugoa will demand reconsideration of the possibilities of this project. The possibilities of the expansion of the Port of Karwar, about 50 miles south of Marmugoa, are also under consideration by the committee. Again, whichever is selected, the effect will be to confine the trade passing through Marmugoa to the small area of Portuguese territory behind it.

A further effort to divert trade flowing from territory of the Dominion of India through other territory is being made by linking up their territory in the hill districts of Assam between East Pakistan and Burma, to the main body of India to the west of East Pakistan. This would be effected by a rail link joining the Assam Railway from the north of the Brahmaputra to their main railway systems via Siliguri, and would divert trade from the area to the north of Brahmaputra to Calcutta, confining the traffic passing through Chittagong to that within the boundaries of East Pakistan.

If these proposals are carried into effect, the trade passing through the principal ports will be almost entirely confined to the Dominions to which they belong, the ports most affected being the Pakistan Ports of Karachi and Chittagong and the Portuguese Port of Marmugoa. Although the trade handled by these ports will be considerably reduced, the existing major ports of the Dominion of India will not be much affected, as the diverted trade will pass through the proposed new ports.

A further proposal of the Dominion of India is to expand the facilities of the Port of Vizagapatam, diverting trade to this port to relieve the congestion of the Port of Calcutta, and to this end, a direct line from Nagpur to Vizagapatam will very shortly be built, tapping the trade of the Central Provinces, Bastar, etc.

In an endeavour to show the effect of these proposals graphically, what may be termed the catchment areas of trade of the major ports with these developments carried out, has been shown hatched in outline on the map showing the principal ports and railways. These areas have been defined arbitrarily by the writer from an experience of 37 years in the ports and railways of India, but have no other authority. If, however, they help to clarify the position and give an indication of the probable effect of the partition of India on the major ports it will have served a useful purpose.

\* These recommendations were included in an article, "A Survey of Indian Ports," which was published in the July, August and September, 1947, issues of this Journal.

# Harbour Supervision Radar

## Description of Equipment at the Port of Liverpool

### SHIPBORNE AND SHORE RADAR

**I**N recent years considerable progress has been made in overcoming the delays due to fogs by the development of Radar equipment.

Radar was first used at the beginning of the late war to provide warning of the approach of enemy planes and ships, but it was soon realised that the ability of Radar waves to penetrate rain and fog meant that Radar could perform a number of tasks of inestimable value to the mariner. It was not long before shipborne Radar was being used to provide warning of collision, and to obtain approximate navigational information when near land. The amount of navigational information which could be obtained from Radar was at first strictly limited by the crude nature of the equipment but, as the war progressed, more and more attention was paid to developing navigational Radar.

This development proceeded until to-day there are many commercial vessels fitted with a Radar designed to permit reliable navigation and pilotage in bad visibility, and of such a character as to be conveniently operated by the watch-keeping officer. The story of navigational Radar is now widely known, and it is not proposed to elaborate on it here.

It has also become evident that Radar can do for the harbour what it has done for the ship and thus enable a Port Authority to provide full information on all ships in the harbour and its approaches, which will greatly assist in the smooth running of the port in conditions of bad visibility. Radar technique has now advanced to the state where design of suitable Radar equipment for harbour use can be undertaken with confidence.

### OPERATIONAL CONSIDERATIONS

#### The Role of Harbour Radar

Many discussions have taken place, and a number of articles have been written, on the use which can be made of Harbour Radar, and it is now possible to state clearly the tasks which a suitable installation could perform, and to ascertain their operational value to a large modern port such as Liverpool. Let it be made clear from the start that the navigation of a ship in intricate channels must remain in the hands of the Master and the Pilot. The use of shore-based Radar in this respect will be informative both to the Port Authority and to the Master and Pilot of a ship.

#### Radar-fitted Vessels Approaching the Port

A vessel fitted with reliable Radar, bound for Liverpool in foggy conditions, would have no hesitation in proceeding as far as the Bar Light Vessel, but at this point her Master would be faced with the alternatives of anchoring or proceeding up the narrow channel to Liverpool. In weighing up these two alternatives the Master would have in mind the fact that a large vessel, once in the channel, must go through, since there would not be sufficient room either to turn or to anchor with safety. He would know that he could take his vessel through with the aid of the Radar so long as the channel was clear of shipping but, since his own Radar could not show him much of what lay at the far end of the channel and nothing of what lay within the river mouth, he would probably feel unjustified in attempting the channel and would either anchor or ask the Shore Authorities by radio telephone for a report on the state of the shipping in the channel beyond his range. It is here that the Shore Authorities would meet a difficulty. Without shore-based Radar they could not know the situation of shipping in the channel and river during fog. With shore-based Radar the situation would be clearly indicated and the Port Authority enabled to supply the necessary information. Now that a large number of major vessels are beginning to fit navigational Radar, it is easy to foresee that such

requests for information will soon be forthcoming, and with increasing frequency as more ships carry Radar.

Used in conjunction with a good communication system, shore-based Radar would enable incoming vessels to berth, when otherwise they would be compelled to anchor and perhaps miss several tides. In the case of Liverpool, a good ship-to-shore R.T. service is available.

#### Radar-fitted Vessels Preparing to Sail

In the case of a vessel at a major port, such as Liverpool, being ready to undock and preparing to leave the port in fog using her Radar, the Master would be faced with the same problem of being committed to the channel after leaving the dock; consequently he would be loath to leave unless he knew that the channel beyond his own Radar range was clear of shipping. In the dock his own Radar would be of little use to him, since the view of the channel would be masked by cranes, buildings and other vessels, etc. The shore-based Radar, with its greater aerial height and favourable site, would provide the information the Master required, and so prevent serious delay to the sailing of the vessel.



Fig. 1.—View of the 80-ft. Ferro-Concrete Tower.

#### Vessels without Radar

In conditions of light fog or mist a vessel not fitted with Radar might well be prepared to enter the channel or leave her berth, provided that her Master knew exactly what was the state of the channel. Shore-based Radar would be then not only the complement of shipborne Radar but could also provide a useful service to non-Radar-fitted vessels.

## Harbour Supervision Radar—continued

### Channel Blockages and Casualties

In the event of the channel becoming blocked, this fact could be observed immediately by shore-based Radar, and in consequence shipping about to enter the channel could be warned without loss of time. The shore-based Radar would also reveal any stranding of vessels within the port and save valuable time in locating the casualty, and might result in the saving of a vessel which might otherwise have been lost.

### Use to other Port Officials

Harbour Radar could also be of assistance to pilot boats not equipped with Radar in enabling the Pilot to find and rendezvous with a ship approaching the port in fog.

Harbour Radar would enable a Port Authority at all times to observe and check the positions of navigational sea marks within the port area and approaches. If such navigational marks were out of position, this fact would be disclosed by shore-based Radar, and the Port Authority would be enabled to warn shipping and to replace the marks on station without delay.

Shore-based Radar would also be a valuable means of assisting vessels in the calibration of their directional wireless in fog.

In addition, the Port Health Officer, Customs and Immigration Officials could be better informed as to the movements of all incoming vessels, and much time would be saved by this definite information.

### INVESTIGATION OF REQUIREMENTS

#### Early Trials

In the Spring of 1946 the Admiralty made available a mobile Radar equipment with which some preliminary investigations were carried out at Liverpool. This was a 3-cm. Radar equipment with a bearing discrimination of about  $1\frac{1}{2}^\circ$  and range discrimination of 150 yards. This equipment was housed on the top of a warehouse near Gladstone Dock, where it had a good view of the approach channels, and was used to find out more about the required characteristics of a suitable Harbour Radar.

Although at first inspection the pictures given by this equipment were quite good, it soon became apparent that its performance was not adequate for the job it was being asked to do. It was quite clear that the scale of the displays were inadequate, since some 14 miles of approach channel were compressed into the 4-in. radius of the display, thus making accurate reading almost impossible. As a temporary measure, a different type of display (known as a "B" scope) was added to the equipment, giving a larger scale view of a selected part of the area; this display gave a 5-in. diameter picture, which showed a region of about 3 miles in diameter which could be moved to cover any selected part of the channel. It now became possible to see with some clarity the positions of vessels at the far end of the channel; the picture was, however, by no means satisfactory from an operational point of view, since a "B" scope always gives a distorted form of picture, which in this case made it difficult to recognise the shape of the channel. Even using this expanded display, the clarity of the picture was still not good enough, chiefly due to the inadequate bearing discrimination of  $1\frac{1}{2}^\circ$  given by the equipment, and also to some extent due to the inadequate range discrimination of 150 yards. This agreed quite well with what had been expected when the equipment was taken to Liverpool, but it was very valuable to have this practical confirmation. The Harbour Board considered that the equipment had given a very useful idea of what could be expected from Harbour Radar, provided that considerably improved equipment became available.

#### Subsequent Investigation

Following on these trials, the Sperry Gyroscope Company, Ltd., in collaboration with the Mersey Docks and Harbour Board, carried out a very careful investigation into the precise requirements for an equipment which would provide really effective harbour supervision; in this they were glad to have the willing and helpful co-operation of some Admiralty scientists. Examination was based upon the list of operational needs as seen by the Harbour Board, upon the charts and plans of the area, and upon

experience gained in the Radar trials. In addition to this examination at Liverpool, some consideration was given to the requirements of other typical ports and harbours in order to find out whether it would be possible to produce a single equipment which would be satisfactory for the majority of harbours. It has since become clear that, although basic problems are the same in a large number of harbours, there are very important elements of difference depending on the natural geographical characteristics of the harbour concerned; it therefore seems that, while it should be possible to arrange that some parts of the equipment are perfectly standard and could be used in widely different conditions, a large measure of individual planning will be necessary for each particular harbour, and individual equipment will have to be constructed to meet its particular needs.

The list of requirements set out below is based upon these investigations, and enumerates the chief points of importance for an equipment specifically designed for Liverpool. Although the general sense of these requirements is applicable to most ports, they should be regarded as specific rather than general.

### SOME OF THE MAJOR REQUIREMENTS

#### Very High Discrimination

In view of the 14-mile length of the approach channels to Liverpool and their narrowness, it is clear that the equipment must have a very high discrimination, and this should be better than  $1^\circ$  in bearing by about 40 yards in range.

#### Large-scale Displays

To facilitate ease of reading of the displays, the displays must be to a large scale, and something in the region of one in thirty or forty thousand is considered satisfactory.

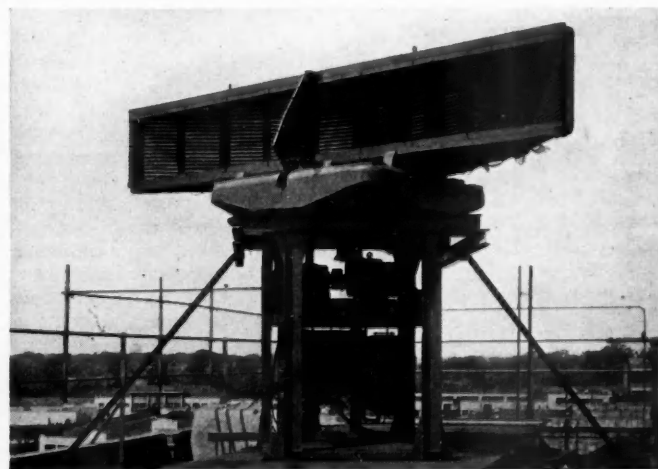


Fig. 2.—Photograph of Radar Scanner, taken at the recent demonstration at Brentford. The Scanner was subsequently conveyed to Liverpool and mounted on the Tower shown in Fig. 1.

#### Ease of Operation

In conditions of high shipping density it would be very easy to confuse the echoes from the navigational buoys and from the ships, and some means must be included in the displays of identifying the fixed navigational marks. In addition, it will often be required to fix the position of a ship with accuracy and speed, and some means of allowing this to be done in the most convenient form will be a very important part of the system. The equipment will often have to be used by a single non-technical operator who may, in addition, be responsible for operating the Harbour Board's communication equipment. It is therefore important that the equipment should be simple to use; this applies not only to the process of switching the set on and off and adjusting it, but also to the means of obtaining information from it. An operator who has more than one task to perform may easily obtain incorrect information from any equipment which is difficult to use, particularly when the operational conditions are such as to demand

## Harbour Supervision Radar—continued

rapid action. For this reason it is of the utmost importance to make the equipment really straightforward and to give clear unmistakable pictures.

### Remote Display

It has been decided that in the early stages it will be acceptable for the Radar information to be displayed only at the site of the

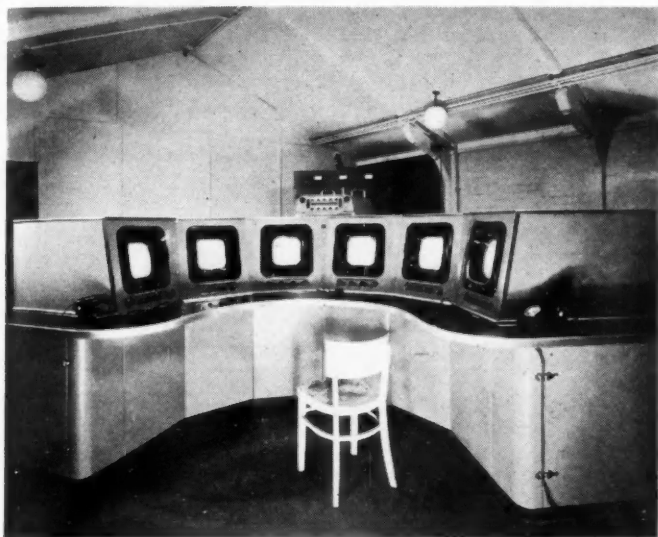


Fig. 3.—View of Display Console and Transmitter-Receiver Rack (in background).

Radar installation, and for this to be communicated to the Port Authority's office by a system of reporting over a private telephone line. It would, however, be much preferable for the port official concerned to be provided with Radar displays in his own office, and the equipment should be planned in such a manner that this facility of transmitting the Radar output over several miles to drive a remote display can be added to the equipment at a later date.

### Reliability

Perhaps the most important requirement of all is that the equipment should be thoroughly reliable and capable of operating continuously for several days when conditions of visibility demand it. Such maintenance as is necessary on the equipment should be capable of being performed by a radio mechanic, and should not demand the attendance of a highly skilled technician.

It may be of interest to describe a few details of what has been planned for Liverpool, in order to give some conception of the type of installation.

### DETAILS OF THE EQUIPMENT

#### Site and Layout

The equipment has been sited at the north-west corner of Gladstone Dock, where it commands an unrestricted view of the estuary of the Mersey as far as the Princes landing stage, and of the whole of Liverpool Bay. A building houses the Radar equipment, the communication equipment, the generators and the stand-by diesels, and also provides rest facilities for the crew. Alongside this building is an 80-ft. ferro-concrete tower (Fig. 1), at the top of which has been mounted the Radar scanner.

#### Radar Scanner.

A photograph of the Radar scanner is shown in greater detail in Fig. 2. The scanner and drive mechanism, which weighs approximately 2 tons, is capable of giving a bearing discrimination of  $\frac{1}{2}^\circ$ . Despite its large size, it has been designed to very fine limits so as to minimise the effects of "side lobes," which can otherwise

give rise to spurious signals on false bearings. The scanner has been designed to withstand, and to continue to rotate in, high winds up to 100 miles per hour, and heaters are built into the scanner to ensure that it does not ice-up under conditions of very cold weather. The driving mechanism for the scanner mirror is housed in a room at the top of the tower, to which access may be gained by a ladder running up the inside of the tower; by adopting this form of construction, instead of the more usual cast pedestal, any routine maintenance of the motor and gearing, etc., is rendered very much easier, since a man can work inside this room in comfort.

### Display Console

The display console contains six plan displays (Fig. 3) and the controls necessary to operate the whole of the equipment.

The first of these six displays shows a small-scale view of the whole of Liverpool Bay, giving a maximum range of 13 miles; it can also be switched so that it shows a maximum range of 20 miles.

Four of the remaining displays each shows a large-scale view of some part of the channel, as indicated in Fig. 4. These latter displays are of a new type which show a precision picture of any desired part of the channel and which give a true plan presentation. Each of these four displays will be set up to the same natural scale and will slightly overlap each other. Thus an uninterrupted view of the area is given which is of much larger size than could be accommodated on a single cathode ray tube.

Each of these displays will have a chart of the appropriate part of the channel in front of it, with all buoys and other navigational marks plainly indicated on it, so that identification of the echoes from these objects is rapid and unmistakable. A rectangular grid will also be shown on each display, so that the grid reference of any echo may be read directly, and hence can be readily plotted on a chart with the same standard rectangular grid marked on it; in this way the position of any vessel can be fixed much more rapidly than would be possible if range and bearing strobes were used and if range and bearing had to be plotted on a chart before the "fix" could be made. This rectangular grid reference can, when desired, be communicated directly to any vessel requiring a "fix" without the necessity for previous plotting on the chart. The sixth display is also a large-scale precision display, but whose area can be moved over any part of Liverpool Bay at the will of the operator.

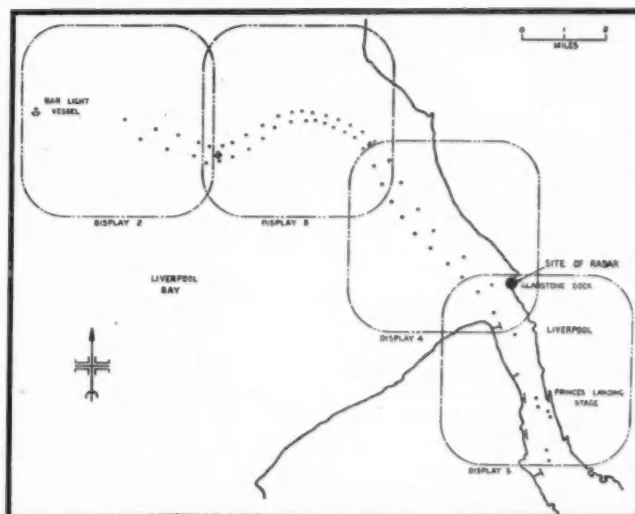


Fig. 4.—Diagram showing how the channel is covered by four large-scale displays.

### Remote Display

Throughout the design of the equipment, circuits have been chosen which are well suited to the eventual transmission of information over a radio-link system to remote displays, and careful

### Harbour Supervision Radar—continued

thought has been given to the characteristics of the radio link itself. Consequently this facility of remote displays can be added at a later date without the necessity of scrapping equipment already installed.

#### APPLICATION TO OTHER PORTS

Each harbour presents its own individual problems and it would be unwise to attempt to produce a stereotyped design of Radar equipment. In the majority of ports, the probable density of shipping and the need for accuracy will demand the use of a high order of discrimination. It may well be that most ports will not require the extremely high discrimination called for at Liverpool, but in all cases it is probable that a discrimination of about 1° will be necessary.

by 6-ft.) of the port area. All vessels within range of the Radar will be plotted on this chart by small flags with the vessel's name inscribed thereon, as soon as identified by report, together with all subsequent movements as defined by further reports. For example, six vessels are plotted on the Radar screen as observed to be entering the port approaches inward. Upon arrival at the bar, these will report by R/T. It is assumed that four of these vessels decide to enter the channels and that two vessels decide to anchor at the bar to await improved conditions. The four entering vessels will report: "So and So arrived bar and entering." Their subsequent reports will be: "So and So passed bar, inward." The remaining two vessels will report: "So and So anchored bar." Further periodic reports will be received from the inward vessels, from established "Report Stations," or if a decision to anchor in the channels, a report will be received thus:

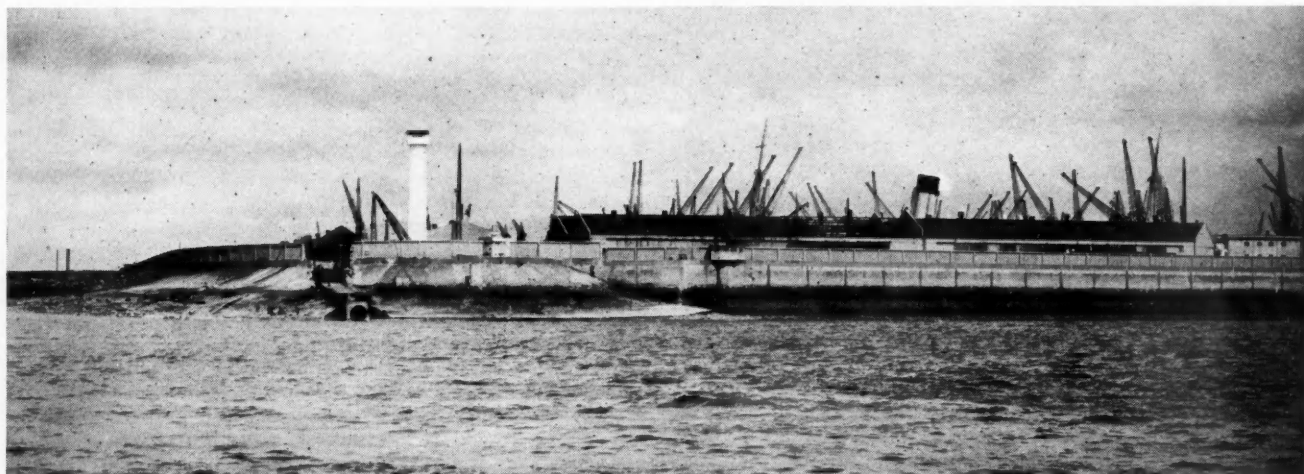


Fig. 5. View taken from the River, showing Tower with Scanner in position.

The display arrangements will, in all cases, need to be arranged to meet the particular needs of the harbour concerned, the number of displays depending on the length of the approach channel, and the scale and disposition of the displays upon the combination of the geographical features. In many ports the optimum siting for the Radar installation may be far away from the Port Authorities' office, and the radio-link system for remote displays may be an essential requirement.

#### METHOD OF IDENTIFICATION OF VESSELS

At the recent demonstration of the Liverpool Radar Installation, which was held at the Sperry Works, Brentford, before a large number of delegates of the Convention for Safety of Life at Sea, several queries were raised as to the procedure which is likely to be adopted by the operating Port Authority to provide primary and continuous identification of a number of vessels navigating simultaneously within the port area. This is how it will be done.

Pilotage is compulsory at the Port of Liverpool (except for small vessels) and all pilots are already equipped with portable R/T sets, with which they can make contact with several established shore R/T stations. On the dock estate, the Radar Station will become one of these. Certain salient positions within the port area will be established as "Report" Stations. All vessels arriving at, and/or passing such positions, will be required to notify the Radar Station accordingly. They will also give notification of coming to an anchor anywhere within the sea channels leading to the river. The salient positions referred to above will be: The Bar Lightship, 13 miles distant from Radar Station; The Formby Boat Beacon, 9 miles distant; The Crosby Boat Beacon, 5 miles distant; and a further point abreast of the Radar Station, i.e., the river entrance. Rules as to notification will be applicable to all vessels, both inward and outward bound. The Radar Station will be fitted with a large scale chart (say, 6-ft.

"So and So anchored Crosby Channel, square . . ." In any case, the position of such vessel is determinable by Radar. It is not customary for "sizable" vessels to overhaul one another in the sea channels, but if, as occasionally occurs, such action becomes necessary, this action will become the subject of a report, to avoid confusion in continuity of identification, although continuous Radar observation negates this. Upon arrival in the river, the anchorages of the vessels will be reported, if not docking on that tide, and similar reports will be made from vessels undocking and remaining in river anchorages.

By reference, therefore, to the Radar Station chart, the information on which will be relayed by 'phone to a duplicate chart in the office of the Marine Surveyor, a complete picture is continuously available of all vessels within the port area, with their respective identities and movements.

This method, with the limitations imposed by the absence of Radar, was put into practice and proved very successful during the late war.

As we go to press we learn that installation of the equipment at Liverpool has been completed, and final tests and calibration have been undertaken by Harbour Board officials and Sperry Engineers. The equipment was officially opened by the First Sea Lord, Admiral of the Fleet Sir John Cunningham, G.C.B., M.V.O., on July 30th, and some of the operating staff have already been appointed. Thus it should be possible for some considerable experience to be obtained by the Harbour Board Marine Surveyor's Staff before the advent of early winter fogs when it is anticipated that the great value of the equipment will be clearly demonstrated. A photograph of the tower and scanner on the corner of the Gladstone Dock is shown in Fig. 5 above.

## Reviews

**"Piling for Foundations,"** by R. R. Minikin. Crosby Lockwood & Sons, Ltd., 39, Thurloe Street, S.W.7; 208 pp., 115 illustrations, price 15s.

The aim of the author, as he says in the preface, was to provide a useful technical guide to the economic design and practical efficiency of piled systems.

The manner of treatment makes a very readable book. The important points touching upon the various methods, or systems, are competently explained without unnecessary elementary detail. Those matters best described by manufacturers' catalogues, or advertisements, are fortunately not included in the text. Perhaps the author might have included more tabular matter for the convenience, under one cover, of designers, but he seems justified in omitting those details, which he points out are better obtainable from the handbooks of the Piling firms.

The text is divided into three main sections:—

1. Bearing Piles.
2. Sheet Piles.
3. When and where to use Piles.

The matter on the whole is not new to the experienced Piling Engineer, but there is a great deal of sound practical information, given in a digestible form, which should be of great value to students, designers, and less experienced engineers. For example, the use of head packing and the assessment of its value as an aid to efficient service is treated, if not exhaustively, at least sufficiently well to show its great importance for optimum results. How often on small isolated piling jobs, carried out by inexperienced contractors, has one seen piles suffer terrific punishment, even to failure, by the neglect of adequate cushioning, or too high a fall of hammer? The same may be said of the correct proportioning of the hammer weight to the weight of pile and the nature of the ground.

The third section of the book is one of interest to most engineers faced with the decision to use or not to use piling. Though all problems are not answered the author's selection of examples covers a wide and useful range which, together with the preceding sections, will prove a helpful guide. The text is simple and lucid: several of the more difficult problems of the designer are skilfully expounded, as for example, the penetration of sheet piles in difficult ground, upon which the author submits an interesting and simple solution.

The printing and workmanship of the book is a fine example of British craftsmanship upon which the publishers are to be congratulated. In conclusion, one can safely recommend the book as a real practical help to a thorough understanding of the subject.

**"Sewage Disposal into Coastal Waters,"** by Harry Clifton. B.Sc., A.M.I.C.E., A.M.I.W.E.; Trans. Institution of Civil Engineers of Ireland, vol. 74, Feb., 1948; Dublin. price 2s.

In one of his moments of Irish wit, Mr. George Bernard Shaw prattled about "the Liffey's smelly shore"; but at least it has never earned the scathing description of Manhattan Island, which an American engineer called "a body of land entirely surrounded by sewage." Mr. Clifton has put his knowledge and experience of the Liffey to more practical use, and from observations and calculations at the Pigeon House outfall pipe of the Dublin Sewage Works, together with reports from American and other sources, he has added to the very limited literature giving reasons and methods against the polluting of coastal waters with sewage discharge. The consensus of his most useful paper is that this need not occur at all if proper calculations are made before a sewer outfall is made and proper treatment is given to the sewage before it is discharged. That such time and money is justified he amply proves; but unfortunately, despite the general adoption of water-borne sewage and the great increase of the populations of seaside towns and ports in modern times, the sea is still regarded as a cheap and easy place for depositing garbage, effluents, domestic sewage and other wastes.

Compared with earlier works on the subject, such as Dr. Southgate's tome on pollution in the Mersey Estuary produced

for the Department of Scientific and Industrial Research, the Californian State report on the 1942 pollution survey of Santa Monica Bay, and Rawn and Palmer's paper on the extent of the sewage field in sea water before the American Society of Civil Engineers in 1929, this new paper is of a very practical nature. I would thoroughly recommend it to the new port authorities at Haifa and other coastal towns overseas, for if Mr. Clifton's advice is carried out shore pollution would not occur. That is, only liquid sewage free from solids would be discharged into the sea, and before a sewer outfall is erected floats would be used to make sure the winds and tides or eddy currents did not bring the surface-dispersing sewage back again on to the shore. At many coastal areas no such thing is done, and amongst my many memories of Haifa will be the human sewage which always littered its bathing beaches despite the letters of protest the public used to write.

Mr. Clifton's conclusion (tactfully made with the advice that each sewer outfall must be considered on its own local conditions of tide, wind, rock-pools, velocity of current and type and quantity of effluent, and with the warning that observations and survey tests are necessary to show how much the existing outfalls conform with the theory of their design), are mainly towards the elimination of injury to bathing beaches, inshore fisheries, smells, dangerous human bacteria and sludge formation, and to emphasise the need for some authoritative control of the increasing amount of sewage and garbage disposal into coastal waters. The maximum pollution load will probably fall with the arrival of the morning load in the case of continuous discharge outfalls, but at the beginning and the end of each discharge period with intermittent discharge outfalls incorporating "tankage," unless arrangements exist to remove the sludge which accumulates between discharges. Float survey data will indicate any risk of solids being deposited on the coast. Currents of 60 and 120-ft. per minute will prevent deposition of organic matter and grit respectively. If more than 120-ft. per minute, they should prevent the formation of sludge banks. Sewage outfall discharges should be metered whenever possible in order to provide a record of flow variation and of the total quantity discharged into the coastal waters.

Hospital and similar sewage is recommended for chlorination at its source. Mr. Clifton has clearly shown that it is the inclusion of solids in the sewage discharge which is the main cause of smells, and of the long life of dangerous human bacteria in bathing waters. But without the Government forcing their hands, will every coastal town find the money from its limited rates to remove the floating solids by skimming and the suspended solids by sedimentation and/or fine screening, as it recommended? Only last December, when writing in this journal\* I mentioned river estuaries in Britain where the deposit of solids has to be dredged up. Mr. Clifton's paper, however, found little space to deal with the dangers to inshore fisheries in anything like the detailed regard for bathing centres, and no mention is made of the extensive pollution studies made in the tidal water of the Mersey, or the alternative method in difficult estuaries of conveying town sewage by barge for disposal at a safe distance at sea, as I've seen Gibraltar tip its garbage out in the Mediterranean. Indeed, the author even suggests hiding the outfall works from human detection and often "its chief offence is to the imagination." To be in an open boat offshore and run foul of the Hoylake sewer through not noticing it is far from a pleasant surprise, probably like the experience of the people of Santa Monica beach in California, inhaling the smell of "ozone," only to be told by the State pollution survey that *Bacillus coli* from human sewage was what they detected in large quantities in that sea breeze along the beach! Even in areas not used for bathing or a fishery, solid matter should be macerated before inclusion, in order to speed its dispersal and purification by the natural action of the purifying bacteria of the sea breaking down first the carbonaceous organic material and then the nitrogenous matter into harmless, stable end-products.

There is the wise suggestion that authorities who cannot afford skimming or screening plant and sedimentation tanks in the outfalls should leave provision in the design for a later inclusion. Many authorities around the Tees, Tyne and Taw for instance didn't include such things when they could afford them; now labour is prohibitive and rates have so many calls.

\*Estuary Mud Banks, "Dock and Harbour Authority," December, 1947

## Reviews—continued

Mr. Clifton draws attention to those factors special to the sea disposal of sewage which differ from inland water disposal. Notable is the sewage rising to the surface over the outfall and spreading out over the surface of the sea, owing to the high specific gravity of the latter, and the system of "streaming" when surface evaporation and resultant salt density make a movement of oxygenated water from the surface downwards, replaced by de-oxygenated water from below, thus speeding the re-oxygenation of the water in proportion to its de-oxygenation by the sewage. In addition the sewage field is more plainly visible on the surface in calm weather due to the electro-chemical precipitation of sewage colloids. The effects of adverse tides and winds, and the retaining action of rock pools are also noted. He might have found a vivid illustration of his warning that the onus of sewage is not ended when it is tipped in tidal waters, by quoting the report on the Mersey Estuary where it was noted that the matter in suspension in sewage discharged at the upper tidal reaches took two or three weeks, journeying backwards and forwards, before it reached the open sea.

How much sewage can be allowed in an area where there is no bathing and no fishery? Bearing local conditions in mind, the answer given is that of the States of New York, Connecticut and New Jersey, namely, no floating solids, and at least 10% of the suspended solids removed and with a minimum dissolved oxygen content of 30% saturation near the point of discharge. In pre-determining the dilution of sewage in the discharge area away from where it first breaks surface at sea level, Mr. Clifton discloses a fallacy widely accepted from Rawn and Palmer's paper to the

American Society of Civil Engineers in 1929. Excepting for low values up to 100, their formula proved to be widely incorrect when applied to the Dun Laoghaire outfall, and it attributes unnaturally high bactericidal properties to sea water. In general the surface dilution over the outfall is calculated from the formula:—

$$(\text{dilution}) D_0 = \frac{0.44 (L + 3) 2.85}{Q^{0.61}} + 1$$

when  $D_0$  = dilution where the sewage first breaks surface at sea level over the outfall,  $L$  = length in feet of the central line of the discharge cone, the shape the sewage mixture takes in reaching the surface, and  $Q$  = the sewage rate of flow in Imperial gallons per minute. In finding out the dilution after this point ( $D$ ) Dr. E. J. Conway, in the Dun Laoghaire Borough Sewage Report, Eire, shows a simple relation of the form  $\log D / D_0 = K.R$  existed;  $R$  being the distance from point of discharge and  $K$  the slope or curve of least fall of sewage concentration, indicating the sewage field. When a number of such surveys are made for different discharges it is possible to estimate how the slope  $K$  is influenced by the volume of discharge and thus predict the sewage field at any new outfall.

Mr. Clifton makes the final warning that it is only by such long-term investigation that the design of outfalls into coastal areas can be improved and existing defects corrected to the safe-guarding of the health and amenities of the district. To the latter I would add the fisheries and navigation channels. All that can be said for silted shores is that they hinder an enemy's beach landings.

ERIC HARDY.

## Correspondence

To the Editor of *The Dock and Harbour Authority*.

Dear Sir,

## The Future of British Ports and Canals

I have read the letter addressed to you on behalf of the Kings Lynn Conservancy Board by their General Manager and Secretary, and published in your July issue. I cannot help feeling that the objects of those Sections of Part IV of the Transport Act, 1947, dealing with harbours, are not fully understood. To take in order the points raised:—

- (1) The objection to my inference that the Transport Commission would not concern itself with the smaller privately-owned ports and those run as adjuncts to private estates as "all harbours in Great Britain other than those specifically excepted by Section 66 (1) are entitled to be considered as trade harbours" is not, I think, logical. Why should the Commission concern itself with, for example, a small Cornish port specially equipped for and handling nothing but stone obtained from a nearby quarry provided it fulfils this function satisfactorily? Obviously the definition of a "trade harbour" is drawn in the widest possible terms, since the whole object as set out in Section 66 (2) of the Act is that the Commission "shall keep the trade harbours under review with a view to determining whether the powers conferred on them by this Section should be exercised with respect to any trade harbour or group of trade harbours."
- Section 66 (3) goes on to state these powers. The Commission "may with a view to securing the efficient and economical development, maintenance or management of any trade harbour or group of trade harbours, prepare, in consultation with persons theretofore carrying on harbour undertakings . . . and with such bodies or persons as the Commission may consider to be properly representative of shipping traders actually using and of workers actually employed in the harbour or group of harbours, and submit to the Minister a scheme . . . constituting or specifying those who are to provide port facilities under the scheme, of what type these facilities shall be, to whom the undertaking shall be transferred, the regulating of the relations of the persons carrying on harbour under-

takings in connection with the pooling of expenses, etc., etc. . . .

I imagine that if it was reported to the Commission that the small Cornish port mentioned above had begun, as the stone trade had become dull, to handle at reduced rates fertilisers, timber, etc., which hitherto had been handled for years quite expeditiously and cheaply by a neighbouring port, the powers conferred by Section 66 would be invoked to determine which in the "public interest" could best deal with the traffic. If found necessary a scheme would, after an enquiry be formulated for submission to the Minister.

- (2) One of the main reasons necessitating legislation arises because the staple industries in certain areas have in the past had to close down through economic difficulties and there has been movement away from them of trade and population. As a result the local ports were often left high and dry. This, coupled with the fact that the Government is now seeking to implement the recommendations made in recent Royal Commissions for the better distribution of British industries and population so as to avoid accretion to the already unwieldy populations of towns like London and Manchester made legislation imperative.

Certain localities in the North West of England flourished when the coal and iron trades were busy. The local ports prospered. Within living memory these industries declined, and there were no others of similar dimensions to absorb imports and furnish exports. The ports came on hard times, and in at least one case a receiver and manager was put in.

There is no denying that the smaller ports provide terminal points for coastwise traffic, but in many cases there are severe Channel limitations (i.e., vessels cannot enter at Low Water), and if any sudden increase of the present population of their natural hinterlands occurred, either through Government action (re-siting of industries) or through say, the discovery of valuable mineral deposits, a situation might arise where they would be unable to cope with the increased traffic. Thus if minerals were discovered, say in West Norfolk and South Lincoln there is no doubt that the problem facing the Wash ports collectively would need the help of the Commission.

The present congestion in certain East African ports has been caused mainly through large tonnages moving because of Government development works, as well as the inevitable

*Correspondence—continued*

commercial back log owing to the war. Such a volume of traffic was undreamed of before hostilities. The British Transport Act provides a means of dealing with such situations and such a state of affairs as now obtains in East African ports would at least be diminished, for when certain moves were planned, suitable action to provide adequate facilities could be taken beforehand.

- (3) To say that the Wash ports are treated as one unit for the purposes of dock labour is rather misleading. The East Anglia Group (Port numbers 40 to 47), includes Great Yarmouth, Lowestoft and Ipswich. These three ports serve hinterlands that are hardly touched by any of the others, and they are not located on the Wash.

The tentative grouping as between the Midland and the Eastern Areas was indicated solely by the fact that the true hinterlands of each of the Wash Ports are not identical. Thus Boston on the Witham serves properly the Lincoln Area and it has good water and rail connection with the Trent Valley and North Midlands. Spalding, Sutton Bridge and Wisbech serve agricultural areas. Kings Lynn would appear to be the natural outlet on the East Coast of the East Midlands as well as the agricultural areas of West Norfolk and Cambridge. The boundary suggested took cognizance of the fact that Boston was the natural outlet for the areas immediately North and North West of the Wash and Kings Lynn served similarly the South West and Southern areas.

The fact that during the recent hostilities the Wash ports were treated as one unit (presumably by defence and port emergency committees) and that "experience has shown this grouping is satisfactory" is no valid reason for perpetuating this set-up if in the public interest it is felt that a much larger unit is necessary (i.e., an area to include at least one port capable of dealing with the larger foreign-going vessels).

- (4) It is appreciated that several of the Wash ports (particularly Kings Lynn and Wisbech) have during recent years done much to improve their facilities, and before the war at any rate, the traffic passing showed an increase, in contradistinction to many of the other smaller ports of this country, many of whom had difficulty in making ends meet.

How much of this increased trade was due to the various agricultural subsidies that recent British Governments have seen fit to distribute, it is impossible to say, but their cumulative effect must have contributed considerably and I have no doubt the upward trend is continuing.

Finally, my paper was submitted for discussion to a body, one of whose functions as laid down in its Charter, is to make a study of Transport in all its various aspects.

The British Transport Act is an experimental piece of legislation and Part IV is one of the most experimental parts of it.

British ports and harbours are controlled by such multiplicity of Managements, sometimes (as in the case of Kings Lynn) having several different bodies responsible for such main functions as river conservancy, dock owning and with privately-owned wharves and quays to further complicate matters.

Even the functions of river conservancy boards vary greatly as between estuaries, and the functions of and means used to implement them vary tremendously as between dock owners.

Most of the larger controlling bodies operate under statutory authority, but nothing is standardised, even for the autonomous ports.

This is an age of standardisation, if efficiency can thereby be enhanced. Even the shipper of goods does not know what his port charges will be as between one port and another.

Surely British ports form a fitting subject for detailed study in these days of export drives, and the more information that can be disseminated on this (to most people) rather obscure subject, the better.

Yours faithfully

W. A. FLERE, A.M.Inst.T.  
July 20th 1948.

6 Valentines Road,  
Ilford, Essex.

To the Editor of *The Dock and Harbour Authority*.

Dear Sir,

**The Supplementary Reserve  
Royal Engineers—Transportation Branch.**

As already announced in the Press, it has been decided to reconstitute the Royal Engineers (Transportation Branch) of the Supplementary Reserve.

The Supplementary Reserve Transportation units were originally raised in 1924-25 and attended annual training camps at the Railway Training Centre, R.E. Longmoor, Hants. The original docks unit was 157 (L.N.E.) Docks Coy., but shortly before the war this unit, with the assistance of the Port of London Authority and the L.M.S. Railway, was expanded into Nos. 1 and 2 Docks Group R.E.

At the end of the war responsibility for the operation of transportation undertakings throughout the world was handed back to civilian agencies as soon as possible, and as a result of this policy, and of demobilisation, the Army Transportation Service is now a mere fraction of its wartime size and most of the units have been disbanded. The old Supplementary Reserve, however, were not "disbanded," but put into "suspended animation," so that if, as is now the case, they were to be revived, the old designations and traditions might be kept alive.

In the new Supplementary Reserve, the Port and Inland Water Transport units will form approximately half the total, a much larger proportion than before the war. Furthermore, units will no longer be raised exclusively from the employees of a particular authority; recruiting will be open to all who possess the appropriate technical qualifications by virtue of their civil experience.

The "home" of the port and I.W.T. units will be the Transportation Training Centre R.E., and they will assemble for their annual training at Marchwood, on Southampton Water, when it is hoped that the social contacts and friendly rivalry that existed before the war will again develop.

The appointment of Honorary Colonel of the R.E. (Tn) Supplementary Reserve, which has been vacant since the death, as the result of enemy action in 1940, of the Lord Stamp, has been revived and has been accepted by General Sir William Slim, G.C.B., K.C.B., D.S.O., M.C.

The following types of port and I.W.T. units are being raised initially:—

H.Q. Port Regt., R.E.; Port Maint. Sqn., R.E.; Port Opg. Sqn., R.E.—Sponsored by the Port of London Authority, Mersey Docks and Harbour Board, the Port of Bristol, and, in the case of former L.N.E.R. ports, by British Railways, N.E. Region.

H.Q. Inland Water Transport Regt., R.E.; Inland Water Transport Opg. Sqn., R.E.; Inland Water Transport Workshop Sqn., R.E.—Sponsored by the Association of Master Lightermen and Barge Owners.

The following officers have been nominated for regimental command:—

Port Regts.:—Lt.-Col. R. B. Oram, O.B.E., R.E. (Traffic Superintendent, P.L.A., E.C.3) and Lt.-Col. G. L. Beckett, R.E. (Traffic Dept., Mersey Docks and Harbour Board, Liverpool 3).

I.W.T. Regt.:—Lt.-Col. F. A. Sudbury, O.B.E., R.E. (Association of Master Lightermen and Barge Owners, Plantation House, Fenchurch Street, E.C.3).

Details regarding recruitment and formation of units have already been circulated to the Civil Authorities mentioned above and to Army Recruiting Offices; all who are interested in joining the Supplementary Reserve can obtain information from these sources. Prospective officers are also invited to communicate directly with the Commandant, Transportation Training Centre, R.E., Longmoor Camp, Liss, Hants.

Yours faithfully,

R. F. O'D. GAGE (Brigadier),  
Director of Transportation.

The War Office,  
London, W.C.2.

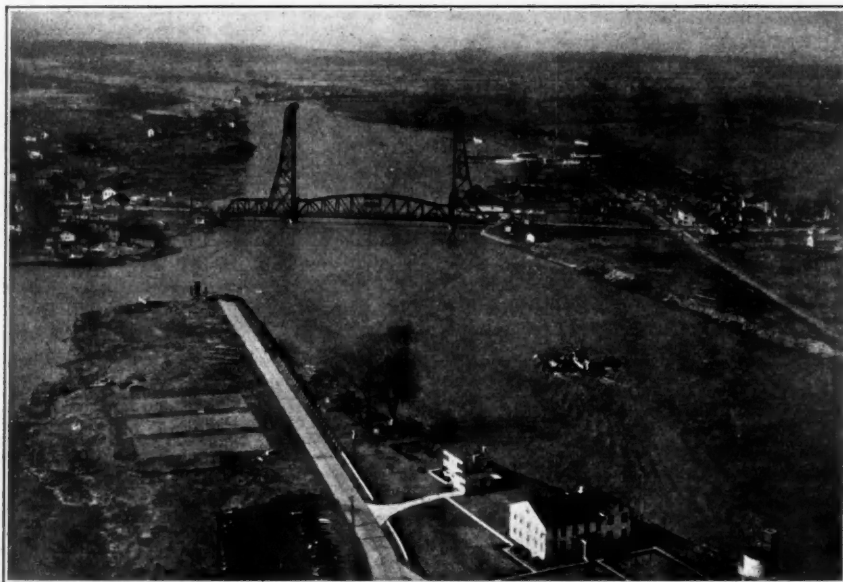
10th July, 1948.

## The Inland Waterways of the United States

By PAUL M. ZEIS.\*

### Development of the Inland Waterway System

During the early period of American history waterways furnished our chief means of transport and were essential to the development of the United States. Great rivers such as the Hudson, the Delaware, the Potomac and the James permitted access to points well in the interior. Somewhat later, in the first half of the 19th century, as settlers pushed across the Appalachian Mountains to



View of the Chesapeake and Delaware Canal.

establish communities in the great central valley of the United States, canals were built to furnish water transportation to the newly-developed areas. The most celebrated of these waterways was the Erie Canal across the State of New York, which furnished cheap water transport between New York City, the Hudson River and the entire area bordering the Great Lakes. The rivers in the great central valley of the United States also became important commercial waterways which hastened the westward expansion of the country. The Mississippi and Ohio Rivers in particular served as the major transport arteries by which products of the interior could reach the sea coast. New Orleans, near the mouth of the Mississippi, became the leading United States seaport with the single exception of New York City.

This period of water transport supremacy ended about the time of the American Civil War, 1861-1865. The rapid development of the railroads between 1850 and 1870 offered a new means of cheap transportation to compete with the services of the water carriers. Operating without any effective government regulation, and with lavish financial support, the railroads soon took nearly all of the business from their water competitors. Most of the canals were abandoned, and river traffic also declined, as shippers turned to the faster and more convenient service offered by the railroads. By the time of the first world war, inland waterway commerce virtually disappeared, except for the traffic on the Great Lakes.

During the last 30 years, however, a substantial revival of traffic on the inland waterways has taken place as a result of a consistent policy of the Federal Government to improve the inland waterways and to foster the development of water transportation. The revival of interest in inland water transportation occurred

about the time of the first world war when severe railroad car shortages impelled a search for other means of transport. This renewed interest in water transport was stimulated by shippers who sought improved water transportation in the Mississippi Valley as a means of combatting high railroad rates. Efforts of Mid-Western shippers were so successful that the Federal Government embarked on a broad programme of navigation on our river system, and the development of dams and installations designed to minimise the effects of floods. The major effort has been devoted to improving the Mississippi and Ohio rivers and their tributaries. For the complete Mississippi River system, approximately \$800 million has been spent for navigation improvements. This waterway, like all other inland waterways in the United States, is available for use without any toll charges. In addition to spending large sums for the construction of dams, locks, and for dredging of channels, the Federal Government also commenced a programme of direct government operation of barge services on the Mississippi and Warrior River systems. A government corporation, the Inland Waterways Corporation, was created to operate a common carrier barge service with a view to demonstrating the feasibility of low cost water transportation in the Mississippi Valley. This corporation which operates the Federal Barge Lines was formerly under the jurisdiction of the War Department but has been transferred to the Department of Commerce.

### The Present Inland Waterway System

The United States now has, including the Great Lakes and the Mississippi River system, an elaborate system of inland waterways, furnishing water transportation to an area including more than half of the country's population. Most of the waterways are rivers which flow into the Atlantic Ocean, the Gulf of Mexico, and the Pacific Ocean. In addition, barge traffic can move through a protected intra-coastal waterway along most of the Gulf Coast and much of the Atlantic Coast. Considerable traffic is carried on the intra-coastal waterway and on Atlantic Coast rivers such as the Hudson, the Delaware, the Potomac and the James and on Pacific Coast rivers such as the Columbia. Most of the inland water commerce, however, is to be found either on the Great Lakes and their connecting waterways, or on the various rivers comprising the Mississippi River system. Since the traffic on the Great Lakes and the Mississippi River system together constitutes more than 90 per cent. of the total, it is considered appropriate to deal rather extensively with these two systems and to make only brief comments concerning the remainder.

A glance at a map of the United States will indicate the key location of both the Great Lakes and Mississippi river system. Water transportation in Great Lakes freighters is available from the Ports Duluth and Superior at the head of Lake Superior to the Port of Buffalo, 986 miles away, or to ports on Lake Ontario. Smaller vessels drawing not more than 14-ft. can operate through the St. Lawrence River and the existing canal system built in connection with that waterway. As a result, water transportation is available from the heart of the country to the Port of Montreal, from which transshipment can be made overseas. A few small ocean-going freighters actually furnish direct service without transshipment from Chicago to Northern Europe. Water transportation is also available from Buffalo on Lake Erie eastward over the New York State Barge Canal to Albany on the Hudson River and thence down the Hudson River to New York City. A branch of the barge canal extends to the Port of Oswego on Lake Ontario and small vessels drawing not more than 12-ft. can travel from Duluth or Chicago to New York City, a distance of nearly 1,500 miles. Most of the commodities shipped over the barge canal however, are transferred from large lake freighters at Buffalo and towed through the Canal in barges. Petroleum products are transferred from ocean tanker to barge at Albany and moved westward through the Canal.

The Mississippi River system has now been improved so that

\*Abstract of a Paper read before the Congrès International des Transports Fluviaux, held in Paris in June, 1947, and reproduced by permission.

## *Inland Waterways of the United States—continued*

there is a 9-ft. channel all the way from Minneapolis and St. Paul to New Orleans, a distance of some 1,727 miles. With the completion of the Chicago Drainage Canal from Lake Michigan and the Illinois Waterway along the Illinois River, there is also available a 9-ft. channel for barge transportation from Chicago on the Great Lakes down the Illinois and down the Mississippi River to New Orleans, a distance of 1,417 miles. The Ohio River, one of the two major tributaries to the Mississippi has also been improved by a series of locks so that a 9-ft. channel is now available from Pittsburgh to New Orleans, a distance of 1,854 miles. The Missouri River, the second major tributary of the Mississippi has a 6-ft. channel to Kansas City and Omaha, but only small tow boats can use it and relatively little traffic has developed.



Lock Entrances at St. Mary's Falls Canal, Michigan.

On the Great Lakes, traffic is handled in large freighters, comparable in size to ocean vessels. On the Mississippi River system, traffic is handled in fleets of barges propelled by powerful tow boats. Single tows often carry more than 10,000 tons of cargo. Individual barges vary greatly in size although many are either 175 or 195-ft. long and carry from 1,000 to 1,500 tons. A few are even larger, carrying as much as 2,000 tons of cargo. Service is relatively slow, but on the lower Mississippi tows make the down-bound trip at speeds in the neighbourhood of 11 miles per hour. Upbound tows average only about 4 miles an hour because of the current.

### **The Great Lakes and Connecting Waterways**

Most of the traffic on the Great Lakes is concentrated in a relatively small number of bulk commodities. In fact, shipments of grain, iron ore, coal, and limestone represent nearly 90 per cent. of the total.

Most of the grain is shipped from upper Lake ports, such as Duluth and Superior, or Fort William in Canada, down the Lakes to Buffalo. From Buffalo the grain is transhipped on smaller vessels through the St. Lawrence Canal system, on barges over the New York State Barge Canal, or by rail to east coast ports. During years of good crops, the grain movement amounts to hundreds of millions of bushels.

The most important single movement on the Lakes is the transport of iron ore from Lake Superior ports down through the St. Marys Falls Canal to Chicago on Lake Michigan or to Cleveland and other Lake Erie ports, from whence much of it is subsequently transhipped to Pittsburgh. This ore movement assumes huge proportions, and during the recent war totalled as much as 90 million tons a year. Without the existence of cheap water transportation, the great steel industry centred around the Great Lakes, would find it difficult to compete with plants located on the sea coast.

Many of the boats carrying ore down the Lakes to Lake Erie ports, return to the upper Lakes with cargoes of coal. Some coal also moves down through the Welland Canal and the St. Lawrence canal system to Montreal. During peak years, coal shipments from Lake Erie ports total nearly 50 million tons.

Most of the limestone is shipped down Lake Michigan to Chicago, or through Lake Huron, the Detroit River and Lake

Erie to Cleveland, and other ports on Lake Erie. In addition to the commodities previously mentioned there is a substantial movement of petroleum products and there are smaller shipments of other bulk commodities as well as a small amount of general merchandise traffic.

Navigation is limited to seven or eight months a year since the Lakes freeze during the year. American traffic is handled by a fleet of more than 400 freighters specially designed for lake service. Some of the new ships are more than 600-ft. long, 60-ft. in breadth, draw 24-ft. when fully loaded, and can carry more than 15,000 tons of ore. These huge vessels are loaded and unloaded by mechanical equipment. Ore and coal are dropped into them through chutes. The boats are normally unloaded by huge bucket cranes. The mechanical equipment used on the Lakes has been perfected to the point where the big freighters can be loaded in as little as 4 hours and can be unloaded in from 8 to 9 hours.

The combination of huge vessels and mechanical loading and unloading equipment has resulted in low transportation costs. The rate on iron ore from Upper Lake Superior ports to Cleveland, a distance of some 833 miles, is usually around 80 or 90 cent. a ton. The rate on coal shipped back to the upper Lakes is even lower, since many of the vessels travel this way in ballast. The coal rate normally ranges around 45 or 50 cents a ton for the 833 mile trip. Grain rates are subject to considerable fluctuations, depending upon the availability of surplus vessels not needed in the coal and ore trades. In recent years the rate has usually been in the neighbourhood of 3 or 4 cents. a bushel for the trip from the upper Lakes to Buffalo.

### **The Mississippi River System**

Nearly two-thirds of the total river traffic of the United States is carried on the Mississippi River System. The largest single item of traffic is coal, and the bulk is carried on the Ohio River and its tributaries, particularly the Monongahela and the Kanawha. This traffic is short haul in nature with most shipments travelling less than 60 miles. For the most part it is concentrated in the vicinity of Pittsburgh. During normal years more than 25 million tons are barged on the Monongahela, another 4 million tons on the Kanawha, a similar amount on the Ohio River itself, and approximately 4 million tons on the Illinois waterway system. While 95 per cent. moves only a short distance, some half-million tons are shipped over the Illinois waterway and up the Mississippi River towards Minneapolis and St. Paul, a distance of five or six hundred miles.

Like coal, most of the iron and steel traffic is also short haul and occurs in the Pittsburgh area. The barges and tow boats are usually owned by the steel companies, although some shipments are made by contact carriers who haul for a number of shippers at rates agreed upon between the parties. Several hundred thousand tons of iron and steel products do move long distances, however, down the Ohio and the Mississippi and a substantial share of the tonnage is ultimately exported from New Orleans.

Grain traffic on the rivers has diminished in recent years, although it still constitutes a fairly large volume. Much of the grain moves relatively short distances on the Mississippi River and the Illinois waterway to Chicago, but a considerable portion moves 1,000 miles down the river from St. Louis to New Orleans and is subsequently exported.

The sulphur movement on the rivers, in contrast to the commodities previously enumerated, is primarily long haul traffic exceeding 1,000 miles. Most of it moves from the Gulf of Mexico or from New Orleans up the river to St. Louis, Chicago and Pittsburgh.

The petroleum traffic includes both short and long haul movements. Many barges move up and down the rivers relatively short distances with crude petroleum or with gasoline. However, there is a very substantial long haul movement of petroleum and petroleum products up the Mississippi and the Ohio. This movement reached huge proportions during the war when the shortage of tankers and railroad tank cars forced diversion of petroleum shipments to alternate forms of transport. Millions of tons of petroleum and refined products move up the Mississippi and the

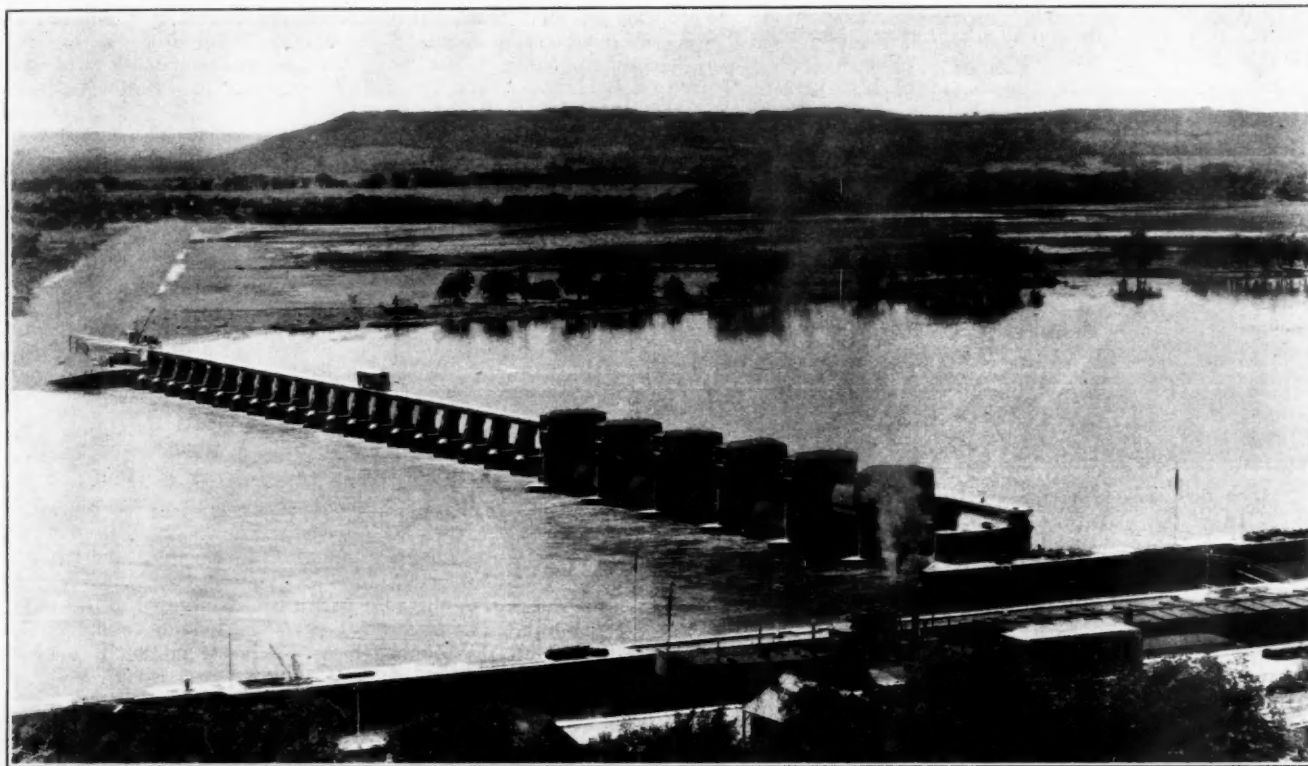
### *Inland Waterways of the United States—continued*

Ohio from Gulf ports and terminals on the lower Mississippi with much of the traffic going as far as Cincinnati. The movement has declined since the end of the war but still amounts to a very substantial tonnage.

While most bulk movements on the waterways are not subject to control, the Federal Government does have jurisdiction over the movement of package freight or general merchandise which is carried by common carriers. These carriers are now subject to much the same regulation by the Interstate Commerce Commission as are the American railroads. They must file their rates with the

ports by railroad. This traffic normally moves under joint rail-barge rates.

Before the war, the Federal Barge Lines carried in the neighbourhood of 1,500,000 tons of general merchandise traffic each year. In addition, some 600,000 to 800,000 tons of grain, coal sulphur were handled. Most of the traffic moved up-stream comprised sugar, coffee, oyster shells, rice, sisal, cotton seed meal, and sulphur, while traffic down-stream included a substantial tonnage of beer, automobiles, iron and steel products, iron pipe, canned foods, and grain. During years of big grain crops, such as



Dam on Upper Mississippi River.

Interstate Commerce Commission and since their service involves problems quite different from those connected with the transport of bulk commodities, it seems desirable to make at least a brief review of some of the major problems which confront them.

#### **Problems of Inland Waterway Common Carriers**

The major common carrier on the Mississippi River is the Inland Waterways Corporation, operated by the Department of Commerce. This Corporation operates the Federal Barge Lines which in normal years handles between 50 and 60 per cent. of the entire merchandise traffic on the river. The subsequent comments with respect to the problems confronting merchandise carriers are drawn very largely from the experience of the Federal Barge Lines, but it is believed that, in general, the experience of this government controlled organisation is similar to that of the major privately owned common carriers.

The Federal Barge Lines maintains regular schedules on the Lower Mississippi between St. Louis and New Orleans, and also on the Illinois River, the Upper Mississippi and on the Warrior River system. On the most important traffic route, between New Orleans, St. Louis and Chicago, two trips a week are made in each direction. The government line furnishes service to all shippers and files its tariffs with the Interstate Commerce Commission as do other common carriers on the rivers, as well as railroads and truck lines. Much of the merchandise traffic handled originates or terminates at inland points and accordingly moves to or from river

ports by railroad. This traffic normally moves under joint rail-barge rates. In 1938, the downward grain movement gave the Barge Lines relatively balance traffic in both directions. In normal years, however, more than 60 per cent. of the traffic moved upbound and many barges were towed downstream empty.

In the last few years the merchandise traffic of the Federal Barge Lines has declined from 1,500,000 tons to about 400,000 or 500,000 tons, and similar percentage declines have also taken place in the case of other common carriers on the river, with the result that the present general merchandise or package freight traffic is scarcely more than one-third its pre-war level. There are several reasons for this startling decline. In part, it was caused by the disruption of inter-coastal and overseas shipping services during the war, since a substantial portion of the merchandise traffic moved by ocean vessels beyond New Orleans. Another reason was the disruption of barge service during the war necessitated by the need for using all available equipment for the movement of petroleum. The major cause, however, arose from the need for accelerated deliveries arising from war-time shortages and the resulting decision of shippers to use the faster, all-rail service. Finally, on many commodities, the railroads adopted a deliberate policy of cutting their rates in an effort to divert business away from the water carriers.

Since the war, the revival of merchandise traffic on the river has been very slow. The railroads whenever possible, have established low rates on traffic susceptible to water movement in an effort to keep it away from the water carriers. More than one-half

## *Inland Waterways of the United States—continued*

of the traffic on the Mississippi normally originates or terminates at inland points, and requires a rail haul in addition to the movement by barge. Accordingly, the basic problem in securing a revival of barge traffic is the relative cost to the shipper of the joint rail-barge service as compared with an all-rail service. Water service is somewhat slower and less attractive than through rail service and accordingly the water carriers must charge lower rates in order to secure the business. This problem of the relative level of rates has been a major issue before the Interstate Commerce Commission for many years.

In addition to objecting to the existing system of rate differentials between traffic moving jointly by rail and barge and traffic moving entirely by rail, the rail carriers have endeavoured to capture much of the business now handled by the water carriers which originates or terminates directly the river ports. As previously indicated the railroads have instituted exceptionally low rates on commodities which might move by barge. The water carriers have consistently alleged that in many cases the railroads are handling traffic at rates which do not fully compensate them for the cost of performing the service. It is claimed that the railroads make up for their losses by charging higher rates on other traffic to interior points where no alternate form of transportation is available. Regardless of the truth of these allegations, it can certainly be said that the railroads have been making a major effort to recapture traffic now handled on the rivers, and that the survival of the water carriers depends upon their ability to offer a service at a lower cost than the railroads can sustain.

In the past it has always been assumed that water transportation is a more economic form of transport service than that furnished by the railroads. With respect to bulk traffic, this assumption is still valid, but in the case of merchandise traffic, particularly commodities originating or terminating at points some distance from the river, recent cost trends cast some doubt on the assumption that barge service is necessarily the lowest cost form of transportation. The difficulty in connection with merchandise traffic, so far as water transportation is concerned, arises from the great increases in handling and terminal costs which have occurred in recent years. Even before the war terminal costs on package freight represented a disproportionate share of total expenses amounting to an average of \$2 per ton of freight. In the last ten years these costs have more than doubled as the result of wage increases and a declining volume of traffic. In 1945, for example, the terminal cost on the Federal Barge Lines for merchandise traffic exceeded \$2 a ton for each handling of a ton of freight. Since in most cases a double handling was involved, with loading at one port and discharging at another, the total terminal cost for merchandise traffic was more than \$4 a ton. It now costs more to transfer freight from rail cars to barges and back again than it does to haul the tonnage 1,400 miles between New Orleans and Chicago.

The experience of the Federal Barge Lines does not necessarily reflect in every respect the results obtained by privately-owned common carriers on the river, but it is believed that mounting merchandise expenses have been experienced by privately-owned companies just as they have by the government-owned line. The evidence is strong that under present conditions, with a reduced volume of merchandise traffic and with soaring labour and terminal costs, most operators prefer to abandon the merchandise traffic and to concentrate upon the haulage of bulk commodities where there is a better relationship between revenues and costs.

If general merchandise traffic on the inland waterways is to survive, radical changes must be effected in the present methods of doing business. Greater concentration should be placed on obtaining long-haul traffic since many of the losses are incurred on the relatively short hauls where the revenue received fails to compensate for the high costs of receiving and delivering terminals. A second solution to the problem is the actual elimination of some of the smaller terminals which no longer provide a volume of traffic at all commensurate with the cost of maintaining the terminal. A third step now being undertaken in an experimental way by the Federal Barge Lines is far more revolutionary and more likely to produce beneficial results. The experiment is to handle general merchandise in large sealed containers holding 5

tons of cargo. These containers can be lifted from rail cars or trucks to barges and back again by cranes. This method eliminates most of the labour now required to handle cargo on a piece by piece basis. Similar containers have been used experimentally at New York City by one offshore steamship line with sensational results in the form of reduced handling charges for cargo. It is believed that adoption of the system on the inland waterways is likely to produce corresponding savings. In fact, it is hoped that the reductions in terminal costs of such magnitude can be obtained that general merchandise traffic will again become profitable.

### **The Future of Inland Water Transport**

It can be stated with assurance that the inland waterways of the United States are likely to become increasingly important to the national economy. Commerce on the Great Lakes can be expected to increase steadily with the expansion of the Middle West and the development of more manufacturing in that territory. As at present, the lake traffic will probably continue to be concentrated in a few bulk commodities.

Commerce on the rivers and connecting waterways is almost certain to increase in the coming years. During the past 25 years there has been a steadily increasing use of the rivers, primarily for the transportation of bulk commodities. With the improved waterways now available, and the powerful tow boats now in service, bulk commodities can be hauled on the river at a ton mile cost of from two to three mills. Coal, petroleum, grain, sulphur and similar commodities can be hauled 1,000 miles at costs ranging between two and three dollars a ton. These costs are so low that the rail carriers are unable to furnish effective competition except in cases where the water haul is unusually circuitous.

The future of common carrier merchandise service is much less secure. At present the water carriers are engaged in a bitter struggle for traffic with the railroads and their success is by no means assured. As indicated earlier, the prospect for continued general merchandise service of any magnitude rests upon a drastic reduction in operating costs, particularly, in the terminal costs involved in loading and unloading.

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### **New Lightbuoy for Sweden.**

One of the most remarkable lightbuoys ever built in Sweden is now under construction at the Karlskrona yard, in the southern part of the country. It weighs more than 10,000 tons and is made of reinforced concrete plate. The buoy is to be sunk to a depth of 30-ft. in the position now occupied by the lightship at Olandsrev, in the Baltic Sea. Its mast will carry a light 80-ft. above the water all the year round.

### **Latin American Broadcasts.**

The extent and scope of the Latin American Service of the B.B.C. are not, perhaps, as fully realised as they should be in Great Britain; careful study has been devoted to broadcasts of professional and technical interest, particularly in engineering, because of the growing realisation of its wide implications and value in countries still developing vast natural resources and rapidly building up their own industries on a gigantic scale. Many thousands of young men in Latin America are keen engineering students.

Two series of broadcasts on Civil Engineering, each consisting of a talk once a week extending over a period of three months, have already been made and a third series is in preparation. This will deal with the following subjects: Diving in Civil Engineering; Excavating and Earth Moving Plant; Oil Tankers; Railway Rolling Stock; Marine Gas Turbines; Grain Handling Plant; Hydro-Electric Plant; Anti-Corrosion Methods for Marine Structures; Tugs and Launches; Measurement and Recording of Vibration; Cranes for Docks and Harbours; Trucks for Internal Works Transport; and British Locomotive Developments. Mr. Rolt Hammond, A.C.G.I., A.M.I.C.E., the author of the talks, has asked us to state that he will be glad to hear from any firms who may have received contracts from Latin America for any of these items, so that he may show what efforts are now being made by British engineers in this vitally important market.

## Mechanisation Trends

### Review of Mechanical Aids displayed at Recent Exhibition

The first National Mechanical Handling Exhibition and Convention was held at the Olympia, London, W.14. from July 12th to 21st. Organised by the magazine "Mechanical Handling" its object was to provide a comprehensive display under one roof of the various methods and equipment designed to help British industry in the drive for more efficient production and export at competitive prices. Besides giving an opportunity of discussing methods and equipments and exchanging ideas, it also showed the many foreign visitors what British manufacturers of mechanical handling equipment can provide and the uses which are already being made of it in this country and abroad.

It has been said that the mechanisation of the handling processes in industry may be the industrial revolution of the present century. The process was given a fillip in war-time when American equipment was brought over to unload Lend-Lease cargoes to meet the demands of D-Day and other combined operations. Much of this modern equipment is now being produced in this country and British manufacturers have brought to it not only improvements in design but also the high reputation for efficiency and good workmanship which they have always maintained as manufacturers of the older types of handling equipment, such as cranes, hoists and heavy lifting gear.

#### Cranes

Most of the cranes on show at Olympia were of the mobile type due to restrictions on space. These cranes were noteworthy not only for their extreme manoeuvrability in confined spaces. The precision positioning of such lifting gear is nowadays delicately controlled by electronics and other means.

One of the smallest cranes on show, weighing 29 cwt., was a petrol-driven runabout capable of lifting a maximum load of 10 cwt. Its chief virtue lies in the low cost of running—about 6d. per hour in fuel—and its ability to work in narrow gangways and to pass through narrow doorways. It is ideal for close work at the dockside with its 180 degree steering lock giving the effect of full circle slewing. The turning radius can be varied from infinity down to a minimum of 5-ft. 8-in.

One mobile crane on show, capable of lifting 4 tons at 40 feet per minute, can unload coal from barge or truck by means of a grab, thus saving 5s. per ton on handling costs. The makers of this crane claim that it releases ten men for productive work and speeds the turn-round of transport of all kinds with consequent saving in demurrage charges and increases in all-round efficiency.

Another small mobile crane made by the same firm can be fitted with an extension mast capable of lifting 6 cwt. to a maximum of 35 feet. Truly a small crane with big crane features!

Makers of the giant cranes were present, but most of their time was given up to demonstrating small models of the real thing and seeing that a good supply of printed matter was available.

Only one mechanical grab was on view, and this was a working model. This well-known firm of grab and dredging plant manufacturers have recently supplied a large order to the Clyde Navigation Trust of Glasgow. They manufacture 100 different types of grab including one designed to assist scientific research into marine life by taking samples from the ocean bed, sometimes two and a half miles below the surface, necessitating a tapered rope. Another takes up ten tons of coal at one bite. This latter operates on a dockside in Spain. There are many other grabs just as interesting but space does not allow a detailed description here.

#### Mechanical Trucks

The biggest single section at the Exhibition was that given up to the manufacturers of the various types of mechanical trucks. Most of these were battery-powered, though there were well-known petrol-driven types, and one claimed to be the first to be powered by Diesel Oil.

Though the fork-lift truck is largely used in industry, increasing numbers are being introduced into dock and harbour undertakings

and a short description of the newest features will be of value here.

A great deal of thought has been given to compact design, and the small turning radius and telescopic lifting gear enable most of these handy trucks to be manoeuvred and operated in narrow aisles and confined areas, and to pass through doorways and under roof girders. Fork lift trucks have recently been lowered into the holds of vessels to assist in loading and unloading, and particularly in the stacking of crates, barrels, rolls of paper and the like.

These trucks are perfectly stable at the full rated capacity—usually one and two tons—and they are exceptionally easy to operate. All controls are within easy reach of the driver, who has a good view of the forks and load in any position.

The majority of trucks stack to a height of 10-ft. Their use with pallets has revolutionised storing, for now not only floor space can be used but previously wasted space to ceiling level.

One ingenious truck—which incorporates the virtues of the lift truck and the platform truck—enables goods to be loaded on to lorries, aircraft or railway trucks at floor height. A stillage is loaded in the usual way—maximum weight 25 cwt.—then, without the driver leaving his seat, the truck is backed under the stillage, elevated slightly and driven away. The load can then be brought alongside the lorry or aircraft, and, by the throwing of a lever, elevated as high as 4-ft. 8-in., ensuring easy loading.

Many fixed platform and elevating platform trucks were on show. These handy trucks are ever popular in docks and harbours, and enquiries from exhibitors showed that many orders, both for home and overseas, had been booked.

British Railways showed a mechanical handling film in their portable cinema. Here again mechanical trucks were well to the fore. One particularly useful shunting tractor took the place of a shunting engine pushing fully loaded railway wagons about the marshalling yards with perfect ease. A small petrol-driven shunting unit—rather like an overgrown motor jack—was easily inserted under a wagon to move it in and out of a shed, or for a few yards in any particular direction as required.

#### Palletisation

The enormous growth of palletisation as an industry reflects the popularity of this economical means of storage and transport. Several firms specialising in the manufacture of wood, steel and paper pallets were showing their wares at Olympia, and to one who had watched with interest the spread of palletisation since the war years, the new ideas were definitely invigorating.

No longer are pallets looked upon as simply something on which to load and store to ceiling height. Now the railways and shipping companies are co-operating, and it is possible for one manufacturer to load his wares on pallets, send them by rail to the docks for shipment and be sure that the customer at the other end will receive them virtually undisturbed.

The whole operation entails no handling other than by fork lift trucks. So compactly do pallets store that every available inch of space on rail and ship is utilised.

The first pallets were rough affairs often knocked together in the manufacturer's warehouse. Any bits of wood that happened to be lying around might be used.

Now pallets produced by the specialist firms are sturdy jobs of wood or metal. And they are not just simply double platforms, divided by battens. There are collapsible box pallets, useful for the transport and storage of loose and irregular-shaped objects. There are double-faced, two-way pallets, wing type, suitable for handling with wire rope or bar slings. There are pallets like wire mesh boxes to hold cased goods of irregular size and shape. And there are even paper mache pallets which cost so little that they can be thrown away after use.

War-time experience in the handling of large quantities of naval stores under adverse conditions convinced the Admiralty that a more scientific system was necessary in future for the efficient supply of ships and store establishments. Although the established methods of the Victualling Departments achieved their ultimate object in keeping units in all parts of the world supplied with food, drink, clothing and mess equipment, they were wasteful in time, labour and even materials. Stores arrived at victualling depots in containers of innumerable sizes and shapes. This necessitated their unpacking, sorting and storing in shelves of bulk supplies, which

### Mechanisation Trends—continued

then had to be repacked into smaller composite units to meet individual indents from the ships. The pallet system recommended itself as a means of avoiding constant packing and unpacking of items to make up the consignment of stores.

By working out a standard transit container which could be palletized, and into which could be packed smaller containers of standard size containing specific quantities of the various store items, stores could be shipped to any point and would there be held for use as required. Each container was numbered and each was designed, not only to take a particular object, but also to fit into the general shape of the load which must fit the pallet.

This system, which has been generally adopted by the Navy, is likely to be introduced by shipping lines, railway companies, and air lines whose stores must be distributed from a central point.

A special pallet truck was on show, its virtue being that it is ideal for the movement of pallets or stillages within confined areas in warehouses and factories as well as for loading railway wagons and lorries. Used in conjunction with fork-lift trucks, it increases the effectiveness of the latter by relieving them of transportation duties. Electrically power-operated, this handy pallet truck has a capacity of up to 4,500 lbs.

#### Lifting Magnets

Several manufacturers of high duty lifting magnets were showing. They claimed that the initial investment for the magnet, and the crane to handle it can be paid for in a very short time. The cost of operation thereafter will then average from 15 per cent. to 25 per cent. of the older methods.

For unloading scrap and the like the magnets are invaluable. A 65-in. magnet can lift up to 60,000 lbs. Even a smaller type can lift 6,500 lbs., depending on the material being handled.

#### Other Exhibits

Many exhibitors had to be content, owing to the size of their products, with the display of models and the distribution of printed literature. These included firms specialising in railway wagon discharging appliances, ash and dust handling plant, aerial ropeways and ore handling plant.

A well-known engineering concern specialising in the manufacture of ore handling plant had, in its tastefully designed stand, an exhibition of photographs which made clear the great service it renders to industry and shipping.

A shipping plant shown has a loading capacity of 800 tons per hour. This has been installed at Camargo, Spain. The hoisting of the delivery arm is high speed so that when the plant has to change from forward to aft holds in the ship at the dockside, only minimum time is wasted.

Another ore shipping plant illustrated was at Luchana. The delivery arm has a telescopic slewing and luffing motion, allowing the ore to spread over the hold without trimming. The capacity is 1,500 tons per hour.

An original exhibit of a different kind was a Builder's Elevator. This enables 2000 bricks an hour to be fed to 16 bricklayers every hour by elevating chain. This not only speeds up building but does away with much that leads to fatigue in the labourer, who no longer has to return to the ground to re-fill his hod. Another labour-saver—a Builder's Hoist—quickly raises two hods containing bricks, slates, mortar or tiles to a maximum height of 16-ft. Mounted on pneumatic-tyred wheels, the hoist can be moved around the site without difficulty by one man.

Proof that mechanical handling is now one of Britain's most important industries is supplied by the fact that the Mechanical Handling Engineers Association now has a membership of forty-five, including some of the most important firms in the country.

#### Petrol Installations at Sunderland.

Following the restoration of pre-war oil bunkering facilities at Sunderland Corporation Quay, the petroleum installation at North Dock has now been brought into use again for the first time since 1938.

### Obituary

#### The Rt. Hon. Lord Ritchie of Dundee

We regret to announce the death of Lord Ritchie of Dundee on 19th July last at the age of 81.

The Rt. Hon. Charles Ritchie, second Baron Ritchie of Dundee, who succeeded to the title in 1906, was born on 18th November, 1866. He was educated at Westminster School and at Trinity College, Oxford. In 1898 he married Sarah Ruth, fourth daughter of the late L. J. Jennings, M.P. There were four sons and one daughter of the marriage. In 1927 his eldest son died at the age of 28. The title passes to his eldest surviving son, Captain the Hon. John Kenneth Ritchie, K.R.R.C.

Lord Ritchie was associated with the Port of London even before the Port Authority was brought into being. His father, then the Rt. Hon. C. T. Ritchie, M.P., as Home Secretary, signed the Royal Warrant constituting the Royal Commission whose recommendations resulted in the creation of the Authority, and Lord Ritchie himself was a member of the Joint Committee of both Houses of Parliament appointed to consider the Port of London Bill. He became a member of the Port of London Authority on its creation on 31st March, 1909, being appointed by the Corporation of the City of London (not being a member of the Corporation), and continued in this capacity until March, 1928, when the Authority elected him as their Chairman.

During his connection with the port, Lord Ritchie saw vast changes in shipping and transport facilities generally, and on his retirement the Authority placed on record: "Lord Ritchie has, by his able leadership and unflinching courtesy, combined with his business ability and intimate knowledge of the Undertaking, conducted the affairs of the Authority with outstanding success."

Lord Ritchie was Mayor of Winchelsea in 1924 and 1936, and, from 1923 to 1928, was Joint Chairman, with the late Sir Joseph Brodbank, of the Poplar Hospital for Accidents (the "Dockers' Hospital"). He became President of the hospital in 1928 and continued to fill this office until his death.

He was one of His Majesty's Lieutenants for the City of London and a member of the governing body of Westminster School. From 1930 to 1941, he was Chairman of the Executive Committee of the Dock and Harbour Authorities' Association, and President from 1939 to 1941.

#### Staff Changes at the Port of London

**General Manager.** The Port of London Authority announce that Mr. T. Williams, the General Manager, will retire on the 1st November next and will be succeeded by Mr. Leslie E. Ford, O.B.E., who is at present the Chief Docks Manager of the Western Region, British Railways.

**Deputy General Manager.** Mr. P. W. J. Martin, M.B.E., has been appointed Deputy General Manager. Mr. Martin entered the service of the Port of London Authority in 1916 and since 1922 has served in the General Manager's office. He was appointed Assistant to the General Manager in 1938 and in 1943 was awarded the M.B.E. for services in connection with the second world war.

**Chief Information Officer.** Mr. C. F. J. Tomlinson is to be Chief Information Officer in succession to the late E. Kingsley Holmes. Mr. Tomlinson has been in the service of the Authority since 1916 during which time he has had considerable experience of the Authority's undertaking in the General Manager's and Secretary's departments. During the war Mr. Tomlinson was Deputy Head of the Marine Salvage Department and was associated with the operations undertaken by the Salvage Service in raising and salving many large ships which had been sunk in the docks and river by enemy action.

#### Port of Southampton Appointment.

The Southampton Harbour Board announce that Captain T. C. Broad who was appointed Assistant Harbour Master in December last, has been appointed Harbour Master as from July 1st, in succession to the late Captain A. E. Bartlett.

## Notes of the Month

### New Dock Works at Liverpool.

With the object of enabling Irish cross-channel ships to enter or leave their docks at almost any state of the tide, a new lock is now under construction at Waterloo Dock, Liverpool. The Mersey Docks and Harbour Board are not yet in a position to give an estimated date of completion.

### Free Port under consideration at Trinidad.

In recent months a scheme has been put before the Trinidad Government for a deepwater wharf at Docksite to be utilised as a free port similar to those established in the United States. It is argued that a free port would enable Trinidad to enlarge its bonded warehouse facilities and thus attract a greater volume of transshipment cargo.

### Dredging at the Port of Spain.

The Trinidad Port Services Department has announced that the channel and basin in Port of Spain Harbour will be dredged to 32 feet at low water in an attempt to berth deeper draft ships at the wharves. The project will take several years to complete and the first stage of the operation will be to dredge several patches that have silted since the harbour was first dredged to 30 feet in 1939.

### Traffic at Southern Region Ports.

The Ports of Dover, Folkestone, Newhaven and Southampton dealt with 1,475,000 passengers in 1947 or 74 per cent. of the total passenger traffic between Great Britain and the Continent. In addition, a total of 229,000 passengers passed through Southampton Docks representing 70 per cent. of the passenger traffic between Great Britain and non-European Countries. This compares with 44 per cent. in 1938.

### Reconstruction of Jetty at Newcastle.

The Tyne Improvement Commission has approved an application submitted by Swan, Hunter & Wigham Richardson, Ltd., for permission to reconstruct a jetty and deposit filling near the east end of the company's Wallsend shipyard. The jetty will be about 410-ft. long and 32-ft. wide, and will replace a timber jetty originally built in 1880, but to which modifications have since been made. It will be of reinforced concrete carried on four rows of 18-in. octagonal piles 75-ft. long.

### Need for Dredging at the Port of Dundalk.

At a recent meeting of the Dundalk Harbour Board it was reported that a deputation had attended at the offices of the Ministry for Industry and Commerce to urge the necessity for immediate dredging of the berths at the port, which were becoming so silted up that traffic is being seriously impeded and would soon be impossible. It was pointed out that the trade of the port was approaching pre-war figures, and Dundalk served a hinterland as far as Sligo. The deputation was told that the department's difficulty was to get a dredger to do the work.

### Survey of the Australian Coast.

It has been announced in Australia that Yampi Sound, the iron ore port in North-West Australia, is expected to be in closer contact with the industrial areas of Newcastle and Port Kembla after the coastal waters between Broome and Wyndham have been surveyed. This survey will enable the iron ore ships to steam north instead of taking the southern route across the Great Australian Bight to the east. The naval survey ship, "Barcoo," is now sounding the waters south of Darwin, an area which is regarded as the least known part of the Australian coastline. The surveys have been in operation for nearly three years and are part of a 30-year plan to provide up-to-date charts of the entire Australian coast.

### Ore-Loading Facilities Restored at Bizerta.

The ore-loading plant at Bizerta, (Tunis), which was destroyed by the Germans in May, 1943, has now been repaired and taken into use again. The Bizerta channel has been cleared of wrecks, but until dredging in the channel and outer harbour is completed, vessels drawing more than 29-ft. 6-in. can enter only at high tide.

### Corinth Canal Re-Opened.

The Corinth canal was formally re-opened early last month, when a ship carrying Greek and American officials passed through for the first time since it was demolished by the Germans in 1944. The canal, cuts across the Isthmus of Corinth for 6,400 feet, and directly connects the Gulf of Corinth with the Saronic Gulf and so shortens the voyage from the Adriatic to Piraeus by over 200 miles. It is expected the canal will be restored to its original state by the end of August, when it will be capable of accommodating vessels of 10,000 tons, and it is estimated its re-opening will save Greek inter-coastal commerce about £50,000 a month.

### Reconstruction of Queen's Quay, Belfast.

A scheme for the reconstruction of Queen's Quay, Belfast, was approved by the Harbour Board early last month. The strengthening and repair of the quay has become necessary in view of the fact that it is 70 years old and now has to accommodate cranes and vehicles considerably heavier than those for which it was originally designed. Also, the delivery in the near future of three new five-ton grabbing cranes of 65-ft. radius will add still further to the strain. The scheme which has been adopted will allow for the provision of a new frontage up to a length of 1,250-ft. from the North end of the quay, and for increasing the present depth of water, which varies from 13-ft. 9-in. to 15-ft. 3-in., to a uniform depth of 20-ft. at ordinary low water. The work will be commenced at the north end of the quay and will be carried out in sections of about 200-ft. so as to cause as little inconvenience as possible to the discharge of colliers.

### Radar for Thames Ferry Service.

In order to improve the ferry service between Tilbury and Gravesend in conditions of bad visibility, radar is to be installed at Tilbury Riverside Station. Hitherto, in dense fog, and by reason of the strong tide and the possibility of vessels anchoring in the fairway, the ferry service has frequently been delayed and sometimes suspended, and it is hoped that the installation of a shore-based radar service will overcome these difficulties so that the service can be maintained in all weathers. The radar set, which will be manufactured by Cossor Radar Ltd., will be installed in part of one of the waiting rooms on the station now being adapted for the purpose, and the scanner will be placed above the clock on Tilbury Riverside station. Communication between the shore and the ferry vessels will be by means of a Marconi two-way radio telephone, and the ferries will be guided across the Thames from berth to berth in a manner similar to that already in operation with the Wallasey ferries on the Mersey.

### CIVIL SERVICE COMMISSION

Applications are invited from male candidates for 14 vacancies (permanent) for Civil Engineers in the Admiralty.

Candidates must be Corporate Members of the Institution of Civil Engineers and must have had basic training in Drawing Office on design and detailing and preferably, also, in the Workshops, and should have had good and varied experience of Civil Engineering, including supervision of Contract Work and execution of works by direct labour, also experience in Estimating and Quantities.

Candidates must have attained the age of 30 by 1st October, 1948. Inclusive London salary scale £750-£1,000.

Further particulars and forms of application from the Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1., quoting No. 2247, to whom completed application forms must be returned by 11th September, 1948 (for candidates in the United Kingdom), or 9th October, 1948 (for candidates overseas).